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Double Stack Container Systems: Implications for U.S. Railroads and Ports

U.S. Department of Transportation
Maritime Administration
Office of Port and Intermodal Development

Final Report

FRA-RRP-90-2
MAR-PORT-830-90009

June 1990

This document is available for purchase from the National Technical Information Service, Springfield, VA 22161

NOTICE

Technical Report Documentation Page

1. Report No. FRA-RRP-90-2 MA-PORT-830-90009	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Double Stack Container Systems: Implications for U.S. Railroads and Ports		5. Report Date June 1990
		6. Performing Organization Code
7. Author(s) Daniel S. Smith, principal author		8. Performing Organization Report No.
9. Performing Organization Name and Address Manalytics, Inc. 625 Third Street San Francisco, California 94107		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DTFR53-88-C-00020
12. Sponsoring Agency Name and Address Federal Railroad Administration Maritime Administration U.S. Department of Transportation Washington, D.C. 20590		13. Type of Report and Period Covered Final Report
		14. Sponsoring Agency Code

15. Supplementary Notes
Project Monitor(s): Marilyn Klein, Federal Railroad Admin.
Andrew Reed, Maritime Administration
400 7th St., SW - Washington, D.C. 20590

16. Abstract

This study assesses the potential for domestic double-stack container transportation and the implications of expanded double-stack systems for railroads, ports, and ocean carriers. The study suggests that double-stack service can be fully competitive with trucks in dense traffic corridors of 725 miles or more. There are opportunities to substantially increase double-stack service in existing corridors and to introduce double-stack service in secondary corridors, in outlying areas near major hubs, and for refrigerated commodities. To meet the challenge of providing and marketing a reliable, high quality, door-to-door service, railroads may have to take unaccustomed steps into marketing and customer service, or become strictly line-haul carriers. Ports must accommodate international double-stack growth, but they will be only indirectly affected by domestic containerization. Intermodal affiliates of ocean carriers will retain their leadership role in domestic containerization, while the ocean carriers themselves concentrate on international movements and markets.

The products available from this contract include the Executive Summary, the Final Report, and the Bibliography.

17. Key Words double stack container systems; railroads; ports; ocean carriers; intermodal, domestic containers		18. Distribution Statement: Document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	
19. Security Classif. (of this report) unclassified	20. Security Classif. (of this page) unclassified	21. No. of Pages 321	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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I. BACKGROUND

A. STUDY BACKGROUND AND PURPOSE

Rapid growth in double-stack container operations has brought the rail industry to the verge of large-scale domestic containerization. The container capacity of the double-stack fleet has increased from 400 container spaces in 1983 to an estimated 30,000 in 1989, while conventional trailer slots dropped by over 20,000. In that same period, rail transfer facilities have been condensed from over 400 ramps into a system of about 215 high-volume mechanized hubs capable of supporting frequent double-stack service in most major rail corridors. The necessary infrastructure for a domestic container system, seemingly unattainable just a decade ago, is largely in place.

Market forces are already in motion to cross that verge and create large-scale domestic double-stack container services in some markets. Domestic container services are routinely marketed by railroads, ocean carriers, and third parties. Yet the wholesale replacement of other intermodal services with double-stacked containers is not a certainty. There are operational, economic, and institutional issues to be resolved. The issue is not whether there will be domestic containerization: it is here. Rather, the issue is whether there will be an identifiable domestic double-stack network. We believe the answer is "yes": the forces are already in motion. The questions are: Under what circumstances? Where? How large? And how do we get there from here?

This study was undertaken by the Federal Railroad Administration and the Maritime Administration to assemble a comprehensive picture of double-stack systems, to determine the potential for domestic double-stack container transportation, and to identify the implications of expanded double-stack systems for railroads, ports, and ocean carriers. The study was performed by Manalytics, Inc. and subcontractors ALK Associates, Transportation Research and Marketing, and TF Transportation Consultants. It answers six major questions:

- What is the status of double-stack container systems?

- o Under what conditions can domestic double-stack container systems be competitive with trucks?
- o What form might a potential double-stack network take?
- o What implications would such a network have for railroads?
- o What implications would such a network have for ports and ocean carriers?
- o Are existing market forces sufficient to bring about an efficient double-stack network?

B. THE DEVELOPMENT OF DOUBLE-STACK SERVICES

1. The Growth of Rail-Marine Intermodalism

There were five major factors in the rapid growth of rail-marine intermodalism:

- o the introduction of the international marine container in the 1960's, which provided a uniform system to carry general cargo in large, unitized lifts;
- o the development of minilandbridge services to the major eastern U.S. markets for Far East imports, which encouraged the creation of load centers and the development of rail rather than all water movements;
- o the emergence of strong Pacific Rim exporting economies in the 1970's and 1980's, which provided the transpacific landbridge cargo and led the ocean carriers to seek domestic backhaul freight;
- o the modern rail infrastructure, including "hub and spoke" rail distribution and availability of lift-on/lift-off equipment at inland as well as terminals; and
- o the development of powerful computer support systems, which permitted managers to monitor intermodal equipment and track shipments.

All five factors emerged in pursuit of competitive advantage, and were accompanied by marketing initiatives and organizations designed to exploit that advantage. Without these five factors, intermodalism as we now know it may have developed over time, but it is unlikely that it would have developed so fast or risen to the current level of operational efficiency and economic advantage.

The United States waterborne domestic trades, because of relatively expensive longshore labor at both ends of the voyage (as compared to only the U.S. end of most international trades), nurtured the development of the marine container in the late 1950's and early 1960's. Although previous ocean-going container systems had been tried, none endured. Sea-Land Service, in the intercoastal trades on the U.S. Atlantic and Gulf Coasts, and Matson Navigation Company, in the West Coast/Hawaii trade, nearly simultaneously developed the modern ocean container.

After becoming established in the U.S. domestic trades, containerization quickly entered international trade. Grace Lines, then a U.S.-flag carrier serving South America, converted two break-bulk ships to carry containers to South America in 1960. Sea-Land introduced the first trans-Atlantic container service in 1966, and Matson inaugurated a Far East container service in 1967. Sea-Land began eastbound commercial container operations from Japan in 1968.

One of the major promises of the container, besides longshore labor cost reductions, was the development of intermodalism: the ability to transfer large, secure, unitized lots of cargo between ships and landside transport. Early in the development of containerization, Sea-Land, Matson, Seatrain Lines, and Atlantic Container Lines, among others, investigated landbridge (from a foreign origin to a foreign destination via two U.S. ports, with a land transport segment connecting the two U.S. ports), minilandbridge (from a foreign origin to a U.S. port destination, but entering the U.S. at another U.S. port on another coast, with a land transport segment connecting the two ports), and microlandbridge (from a foreign origin to an inland U.S. location, but entering the U.S. at a port on a more distant coast closer to the foreign origin). Development of landbridge operations was slowed more by the regulatory environment than by the transportation infrastructure. Domestic rail and truck carriers are regulated by the Interstate Commerce Commission (ICC), while the international ocean carriers are regulated by the Federal Maritime Commission (FMC). Tariffs across jurisdictions were originally prohibited, and through bills of lading and single factor rates (where the ocean carrier charges for, and takes responsibility for, the full intermodal movement, and divides the revenue with the rail carrier off-tariff) were not legal at the time. Ocean carriers and domestic carriers had to issue separate bills and charge independently.

Minilandbridge (MLB) services substitute relatively expensive rail service for more economical water service. However, other factors are involved than just transport costs when considering the viability of MLB services, such as:

- the size of the MLB market;
- the size of the local market at the potential intermediate MLB ports;
- the proportion of high-rated cargoes; and
- the degree of railroad cooperation.

The first MLB tariff was filed in 1972 by Seatrain Lines for Far East cargoes moving to North Atlantic ports via California ports. This particular market was the biggest in the early 1970's, but, importantly, it also had a high proportion of high valued cargoes that would benefit from the faster transit times offered by MLB services. Seatrain chose to serve the North Atlantic states via California ports, instead of Seattle, because of the larger local market in California. After the success of this MLB service, other MLB services proliferated as the economics of the service improved and the demand for faster transit times increased.

The next variation on landbridge service came with the introduction of microbridge services. U.S. consumer demand for imports from the Far East created large containerized cargo flows to the major population centers in the Midwest. These regional centers were, and still are, served with minimum rail or truck hauls by all-water services through Atlantic and Gulf Coast ports, but intermodal services through West Coast ports offered significantly faster transit times. Microbridge services for Pacific Rim cargoes have gradually extended eastward, including cities as close to the Atlantic Coast as Atlanta and Pittsburgh, and now dominate the trade.

Finally, the Shipping Act of 1984 gave an extra boost to landbridge services of all kinds by allowing conferences to offer intermodal single-factor rates. With the rapid growth in containerized imports, moving from the Far East through West Coast ports to Eastern points, the need to improve efficiency and reduce linehaul costs led to the development of double-stack container service.

2. Critical Developments in the Advent of Double-Stack Service

Double-stack container services were not created by the actions of any one party. They emerged instead from a series of actions, each facilitating or broadening double-stack services in some way. The first critical development was the development of the double-stack car itself by a team of Southern Pacific mechanical engineers under the direction of W. E. Thomford. These cars were specifically intended to reduce linehaul costs on SP's Sea-Land traffic in the Southern Corridor. A single-platform version was completed in 1977 by American Car & Foundry (ACF) for Southern Pacific. Subsequent versions produced in 1979 and 1981 grew to three and five articulated units, with five units becoming a standard for all subsequent production.

In July of 1983, American President Lines ran its first experimental double-stack train from Los Angeles to Chicago. Double-stacking was a technological improvement over the intermodal flatcars used in APL Linertrains since 1979. APL sought to maintain and improve on the control it had achieved over inland operations with its conventional Linertrain service, and to reduce linehaul costs on that service. Regular APL double-stack service started in 1984, and was followed by double-stack service by Sea-Land in 1985. Soon thereafter, other ocean carriers, including Maersk, NYK, "K" Line, and OOCL, started dedicated double-stack trains from the West Coast.

Another major factor was Trailer Train's decision to create a double-stack car fleet, which allowed expansion of double-stack services beyond the dedicated trains of major ocean carriers. In fact, with few exceptions, the ocean carriers who purchased or leased cars for their initial trains turned to Trailer Train cars for subsequent expansion. Trailer Train thereafter committed heavily to double-stack technology. Further development of domestic double-stack services is likely to rely on Trailer Train or other firms to supply and maintain pools of double-stack cars.

As these developments were occurring, railroad regulation was substantially reduced between 1976 and 1981, permitting railroads to conduct intermodal business in a much freer environment. In 1976, Congress passed the Railroad Revitalization and Regulatory Reform (4R) Act, which allowed the ICC to exempt certain traffic under limited circumstances. The 4R Act also paved the way for more extensive regulatory reform. The major progress in railroad deregulation came with the passage of the Staggers Rail Act of 1980, which gave the railroads a considerable amount of latitude in determining and modifying rates without the ICC's interference, and backed up the earlier ICC ruling on contracts by permitting contract carriage on rail common carriers. The Interstate Commerce Commission exempted Trailer-on-Flatcar/Container-on-Flatcar (TOFC/COFC) service from rate regulation in 1981, and eliminated all remaining TOFC/COFC rate regulation in 1987. The railroads' ability to make contracts with their customers proved to be an important element in the success of the innovative intermodal services developed during the 1980's.

As Figure 1 shows, intermodal traffic volume grew dramatically in the 1980's, accounting for a growing share of railroad traffic and revenues and demanding a larger share of management attention.

The dedicated "unit" trains of APL and Sea-Land set the pattern for early double-stack operations. The introduction of "common-user" service by Burlington Northern (BN) in 1985 led to far greater flexibility in double-stack operations. The volume contracts offered by BN were more important than the trains themselves. These contracts had three critical features:

- o "tier rates," with unit cost declining in steps as the annual volume commitment reached a series of thresholds;

- o system-wide application, so all traffic between Seattle or Tacoma and points on the BN system could be combined to meet the volume commitment; and

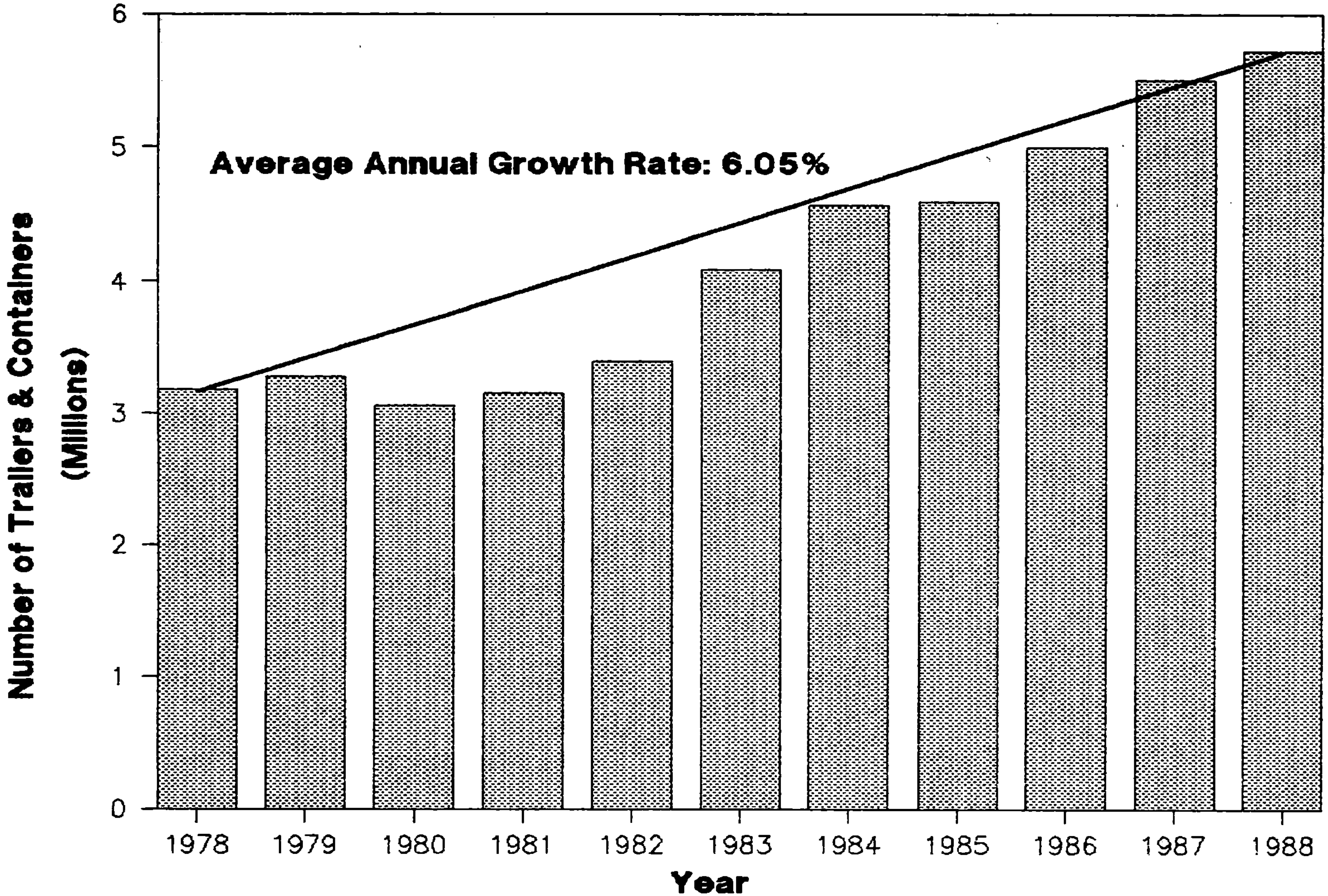

Figure 1: RAIL INTERMODAL VOLUME, 1978-1988

Source: Association of American Railroads
(final revised figures)

- o flexible backhaul provisions, where the customer could solicit backhauls, move containers empty, or have BN solicit the backhauls.

These volume contracts have set the pattern for virtually all new rail contracts, including those for domestic container traffic.

A related development occurred when major double-stack customers began re-marketing dedicated train capacity, thus taking on the role of third parties as well as being shippers. Express Systems Intermodal (ESI), then a subsidiary of SeaPac and OOCL, began soliciting the traffic of other ocean carriers to fill out its trains on SP. Once APC had set up American President Intermodal (API) to operate trains for APL, API also began to solicit traffic from other ocean carrier and domestic third parties, including its own. These actions increased the flexibility of the double-stack system, and provided alternate means for other carriers to take advantage of double-stack economics.

C. KEY ROLES IN DOUBLE-STACK DEVELOPMENT

1. The Rail Role

The rail role must be viewed in the context of overall intermodal growth and a change in the way intermodal traffic has been conducted and perceived. All of the early double-stack trains were dedicated services. Each ocean carrier had a set of double-stack cars, owned, leased, or assigned by Trailer Train for its use. Each service effectively operated as a unit train, although the sets of cars may have been broken up and rearranged from time to time. Thus, for the first year or so, double-stack trains were viewed as unit trains, and operationally distinct from other railroad trains. The introduction of common-user services by several railroads in 1985 and 1986, and the development of multi-destination trains, quickly ended any such distinction. Railroads mix double-stack cars with other intermodal cars to achieve the desired capacity and service frequency. The number of cars and containers on a train will also vary week to week. Almost none of the double-stack trains now operating are true unit trains in the sense of having a fixed car consist.

Despite being occasionally identified as the operators of double-stack trains, only three ocean carriers actually acquired double-stack cars (APL, Sea-Land, and Maersk). Railroads acquired a few cars (either leased or purchased), but the vast majority of double-stack cars has been provided by Trailer Train. Trailer Train Company was incorporated by the Pennsylvania Railroad and the Norfolk and Western Railway in 1955. Now owned by 14 railroads and rail systems, Trailer Train operates a fleet of over 44,000 intermodal cars.

Trailer Train has performed a crucial role in facilitating the growth of double-stack traffic. Once Trailer Train began offering double-stack cars, it was no longer necessary for either ocean carriers or railroads to commit capital to a new service. Until this ability was recently curtailed as a condition of continuing anti-trust immunity, Trailer Train could assign a group of double-stack cars to a specific railroad for a period of several years for use by a specific ocean carrier. By permitting ocean carriers and railroads to start services without the capital outlay for cars, Trailer Train dramatically reduced the barriers to double-stack service and diminished the risks borne by individual carriers.

Three railroads developed intermodal facilities to handle containers exclusively, signalling a new level of commitment to intermodal and double-stack traffic. The Southern Pacific Intermodal Container Transfer Facility (ICTF) in Los Angeles was a joint effort with the Ports of Los Angeles and Long Beach. Its proximity to the ports and its efficiency have been instrumental in attracting the majority of Southern California's container traffic. BN's Seattle International Gateway (SIG) also was built to provide exclusive container transfer facilities adjacent to the port, and has been highly successful in handling BN's common-user traffic. CNW converted an existing Chicago yard into Global One, the first inland facility designed to handle double-stack container traffic exclusively. In each case, the railroad not only responded to an existing need for improved facilities, but looked forward to double-stack growth.

2. The Ocean Carrier Role

Ocean carriers took the initiative to put the double-stack service package together. Railroads were reluctant to develop retail intermodal operations, or to invest heavily in a field that has been marginally profitable. Ocean carriers were willing, for their own reasons, to take the retail role and make both volume commitments and capital investments. Before the development of double-stack services, intermodal container services were usually merged with existing rail TOFC as container-on- flatcar (COFC) traffic. In 1979, American President Lines determined that it could offer better service to its intermodal clients if it had more control over the rail line haul and terminal portions of its system. APL, therefore, contracted for its own dedicated trains and terminal services, and purchased or leased its own railcars. Early in 1984, APL started regularly scheduled double-stack unit train services between Los Angeles and Chicago.

As the success of APL's trains quickly became apparent, other ocean carriers established their own services. Sea-Land, like APL, acquired its own cars for service between Seattle and Little Ferry, New Jersey. Maersk, using Trailer Train cars, began service between Tacoma and Chicago. NYK, using Trailer Train cars, and "K" Line, using the original SP cars, began service between Los Angeles and the Midwest. Intermodal competition forced foreign-flag steamship lines to establish double-stack train services and domestic subsidiaries. The Rail-Bridge Corporation, for example, was set up as a U.S. subsidiary of "K" Line to operate its double-stack services.

The introduction of double-stack service coincided with strong growth of import cargoes in the transpacific trade, which created a heavy eastbound imbalance. Based on Bureau of the Census data, an estimated 1.4 million TEU of imports passed through the West Coast ports in 1984 and only 0.9 million TEU of exports, an imbalance of 1.6:1. The imbalance grew to 1.9:1 in 1985 and to 2:1 in 1986. Since APL leased or owned its initial double-stack cars and had full responsibility to fill the cars in both directions, it had significant incentive to develop additional cargoes to fill westbound containers. In 1985, APL acquired a shippers agent, National Piggyback Services (renamed American President Distribution Services, or APDS) and a distribution service, Intermodal Brokerage

Services, and formed American President Intermodal to oversee its double-stack services while APDS solicits domestic freight and APL solicits international cargo.

While Sea-Land and Maersk also purchased double-stack cars, few ocean carriers made the capital commitment of APL. Most, however, recognized the need to provide double-stack services, and some recognized the opportunity to compete for domestic traffic. The roles played by ocean and rail carriers thus became less clearly defined. Ocean carriers have taken responsibility for a larger portion of the transportation chain from shipper to consignee, and a greater portion of the risks and revenues.

3. The Port Role

Ports played a mix of roles in the development of double-stack traffic. West Coast ports saw double-stack trains as a manifestation of load centering, and their approach varied from simple encouragement to facility construction and proposed sponsorship of double-stack trains. East Coast ports were less involved initially, since the initial thrust of inland container movements came from the transpacific carriers.

The long development times required to develop new port facilities make it difficult for ports to react quickly to new trends. Nonetheless, some ports were able to incorporate provisions for double-stacks in projects underway. The Port of Tacoma's South Intermodal Yard was completed to bring double-stack trains on-dock at the new Sea-Land terminal. In Southern California, plans for the the multi-year ICTF project were altered to facilitate double-stack operations.

Some ports investigated sponsoring or contracting for double-stack operations to serve smaller ocean carriers who could not individually justify double-stack trains. The Port of Baltimore joined with the Chessie System to sponsor (i.e. market) a train. That service has since been melded into CSL's overall intermodal service. The Port of Seattle announced plans to sponsor a dedicated train to provide double-stack service to its carriers. In response, BN began offering the first "common user" trains, with six-day-per-week double-stack service open to smaller steamship lines and third parties, including the Port. The Port of Seattle thereafter abandoned plans to sponsor its own trains, and offered a consolidation plan under BN's tier rates. The Port Authority of New York and New Jersey had trial trains run by Conrail in late 1988, but did not achieve the hoped-for response. The Port of Long Beach had periodically discussed sponsoring a double-stack train for its steamship line clients. By early 1989, with the advent of common-user service in Southern California by SP, ATSF, ESI, and API, the idea was dropped. By offering common-user services, the railroads and multimodal companies have apparently eliminated much of the perceived need for port-sponsored trains.

The Port of Oakland took what is so far (1990) a unique step in facilitating double-stack operations. The Port of Oakland provided about $5 million in a joint effort with UP and API to improve tunnel clearances on UP's central corridor route serving the Port. Work was completed in 1989. A more limited tunnel clearance project was under consideration by the Port of San Francisco in 1989. The San Francisco project would improve clearances through two Southern Pacific tunnels south of the Port.

4. The Role of Risk

Risk plays a major role in any new venture. One can identify five major kinds of risk in the development of double-stack services.

- Technological Risk: double-stack cars and the terminal infrastructure might not have performed as expected.

- Economic Risk: double-stack operations and marketing might have been more costly than expected.

- Financial Risk: the operating savings and revenues might not have justified the capital and market development costs.

- Volume Risk: the service might not have attracted, developed, and retained sufficient volume in both directions.

- Acceptance Risk: double-stack service might not have been accepted by shippers, consignees, and third parties.

As it turned out, double-stack systems did perform as well as expected, double-stack services appear to be economically and financially sound, adequate volume has been attracted and retained, and the service has been enthusiastically accepted by most parties. In the 1970's and early 1980's, however, these risks were real. For double-stack services to begin, each of these risks had to be eliminated or reduced to acceptable levels.

5. Implications for Domestic Double-Stack Services

The history of marine containerization and international double-stack service has useful implications for domestic containerization and double-stack service. The various risks faced and overcome in the international sphere have their domestic counterparts. Some of the critical developments in domestic double-stack service have already occurred.

One hurdle faced by marine containerization has already been passed domestically: the development of a standard container. Although it has not been officially sanctioned by any regulatory body or industry association, the 48-foot long, 8-foot 6-inch high, 102-inch wide container is now a *de facto* industry standard for domestic use, to match the competitive truckload standard. (There are small numbers of 45' and 53' domestic containers for special purposes.)

Of the five major sources of risk -- technological, economic, financial, volume, and acceptance -- three are still present for domestic double-stacks. The technology clearly works, and the underlying economics have been amply demonstrated. Financial, volume and acceptance risks remain.

Financial and volume risk are substantially reduced because domestic containerization and double-stack service began incrementally, as an extension of international services. The first domestic double-stack services did not entail separate financial and volume risks, since they are backhauls to international services. True domestic services -- fronthauls as well as backhauls -- were and are added to trains whose existence relies on an international traffic base.

The successful marketing of international containers for domestic backhauls, and later fronthauls, has greatly advanced the acceptance of the container itself as a domestic freight vehicle. International operations have also yielded valuable experience with the superior ride quality and reduced loss and damage of double-stacks, which have become marketing points. Acceptance by forwarders, shippers' agents, and other third parties who were already intermodal users, however, is not the same as acceptance by shippers who have used trucks exclusively for many years. Because trucks remain a highly competitive and after more efficient mode, domestic containerization faces a more difficult challenge, particularly in market development.

D. STUDY APPROACH

1. Advisory Committee

From the beginning, the study team recognized the critical importance of industry contacts to the successful completion of this study. In addition to the ad hoc contacts made during data acquisition and analysis, the study team assembled an Advisory Committee to review draft reports, suggest improvements, and maintain a realistic viewpoint. The following individuals served on the Advisory Committee and gave generously of their time and expertise:

Donald Cole
Vice President,
Planning & Development
Trailer Train Company

David J. DeBoer
Vice President,
Greenbrier Intermodal

Henry T. Domery
General Manager-Intermodal,
Pennsylvania Truck Lines

James H. McJunkin
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American Association of Port Authorities

Steven C. Nieman
Vice President,
Strategic Planning
American President Domestic

Craig F. Rockey
Assistant Vice President,
Economics
Association of American Railroads

Phillip C. Yeager
Chairman,
The Hub Group, Inc.

The advice and participation of these individuals improved the quality and relevance of the study. The findings of this study, however, do not represent the positions or policies of these individuals or their organizations, and they bear no responsibility for study content.

2. Assessment of Existing Markets and Services

The first task of this study was to establish the status quo for double-stack container systems. The study team drew data from three major sources:

- rail data from the 1987 Carload Waybill Sample (CWS);
- truck data from the 1985-87 National Motor Transport Data Base (NMTDB); and
- maritime data from the 1987 Bureau of the Census foreign trade database.

These data were processed to create a profile of existing relevant traffic flows in all three modes. Information on current double-stack operations and technology was obtained from industry contacts and publications.

3. Establishment of Service and Cost Criteria

The study team developed service and cost criteria to determine the conditions under which domestic double-stack container services could be fully competitive with truckload carriers, who constitute the major long-term competition. Service criteria were based on typical drayage, terminal, and transit times. Cost criteria were based on engineered cost estimates for each function in door-to-door double-stack service. Favorable assumptions were used to gauge the full potential of domestic double-stack container systems.

4. Estimating Hypothetical 1987 and 2000 Double-Stack Networks

The service and cost criteria, translated into volume and length of haul requirements, were applied to the relevant traffic data to generate a hypothetical 1987 core network of truck-competitive double-stack service. A methodology was developed to identify potentially divertable truck movements. Published growth forecasts for domestic and international intermodal traffic were then used to develop a hypothetical year 2000 core network.

5. Implications for Railroads

Implications for railroads were identified in several areas: overall traffic volume; equipment and capital needs; terminal capacity; marketing; and changing roles within the intermodal field.

6. Implications for Ports and Ocean Carriers

Implications for ports and ocean carriers were likewise identified, focussing on the sompatibility of international and domestic container flows; the impacts on port and ocean carrier operations; effects on port/ocean carrier/railroad relationships; and the future roles of ports and ocean carriers.

7. The Intermodal Industry and Domestic Containerization

Statistics and cost estimates are only part of the story, and the intermodal field has transcended the traditional roles of railroads, ports, and ocean carriers. The study team therefore examined the broader implications of domestic containerization for the emrging intermodal industry and the ways in which the participants do business.

II. EXISTING MARKETS AND SERVICES

A. RELEVANT 1987 TRAFFIC FLOWS

1. Rail Traffic Flows

Data Source. The source for rail data for this study is the 1987 Interstate Commerce Commission Carload Waybill Sample (CWS). The study team extracted all intermodal data (trailers and containers) from the 1987 CWS, and selected carload data. The intermodal data were classified as follows:

- Intermodal moves (all trailers and containers, regardless of car type);
- TOFC moves (trailers only);
- COFC moves (all containers, regardless of car type); and
- Identifiable double-stack moves.

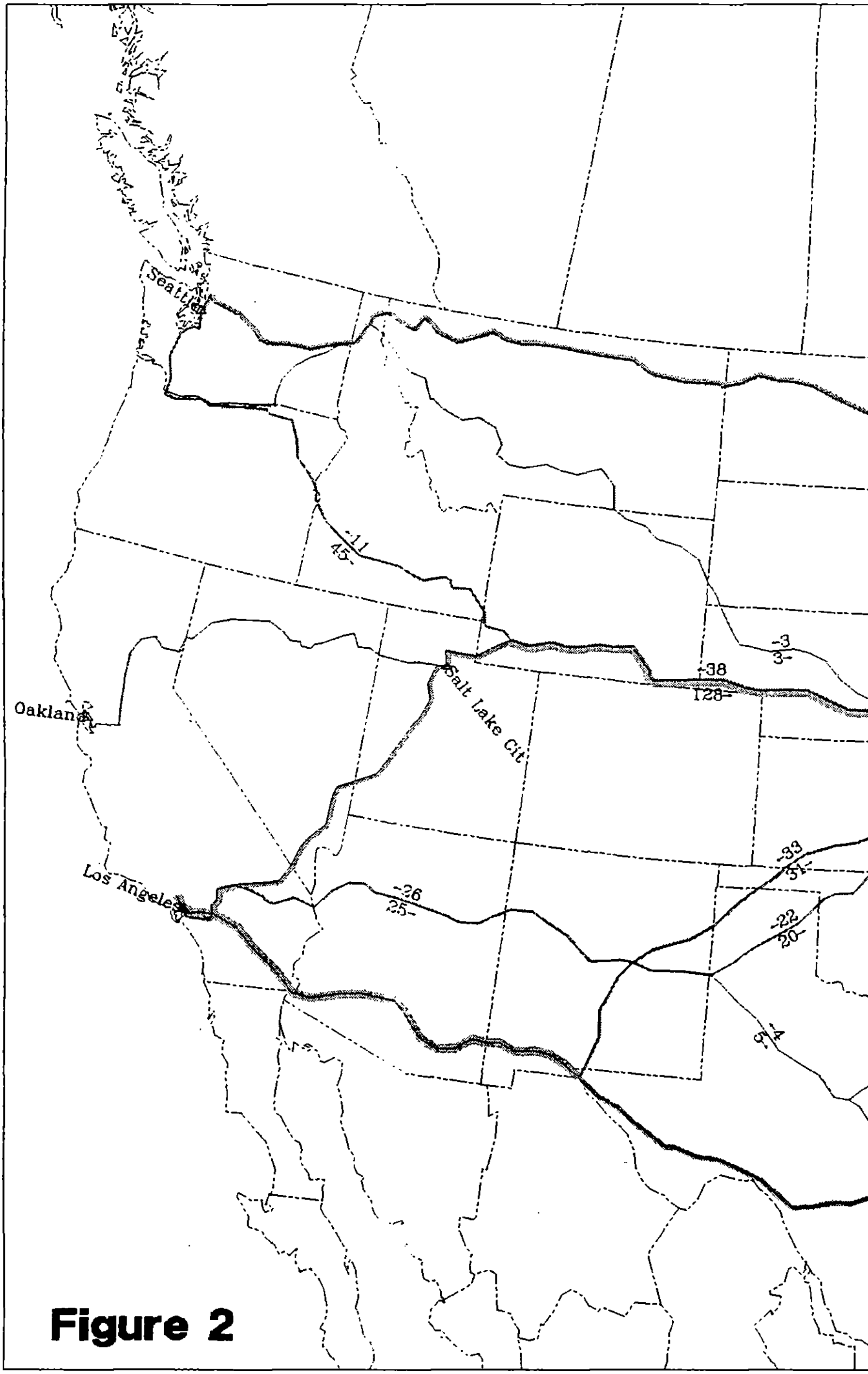
Identification of Intermodal and Double-Stack Traffic. The identification of intermodal traffic in the CWS is quite reliable. The identification of current double-stack traffic as a subset of the reliably known intermodal traffic is not clear cut or reliable. Although railroads are required to report the actual car initial and number which was used to transport intermodal equipment, there are two problems with the use of the cartype field in identifying double-stack traffic. First, if a CWS record covers the movement of more than one car, only the first car's initial and number are reported. Since rail waybills tend to cover the movement of similar goods, this is not a serious problem, as equipment following the first car is likely to be similar to the reported car. Second, many railroads simply do not record what actual cars they are hauling. Since the actual waybill covers the movement of the trailers or containers, and not the cars on which this equipment was loaded, the waybill and revenue settlement processes do not capture the actual railcar used. To help alleviate this problem, the ICC has given permission to railroads to report a representative car initial and number, which in many cases is not a double-stack car.

The remaining question of how many other similar movements were missed which are also likely double-stack services by rail is unanswerable from the Carload Waybill Sample.

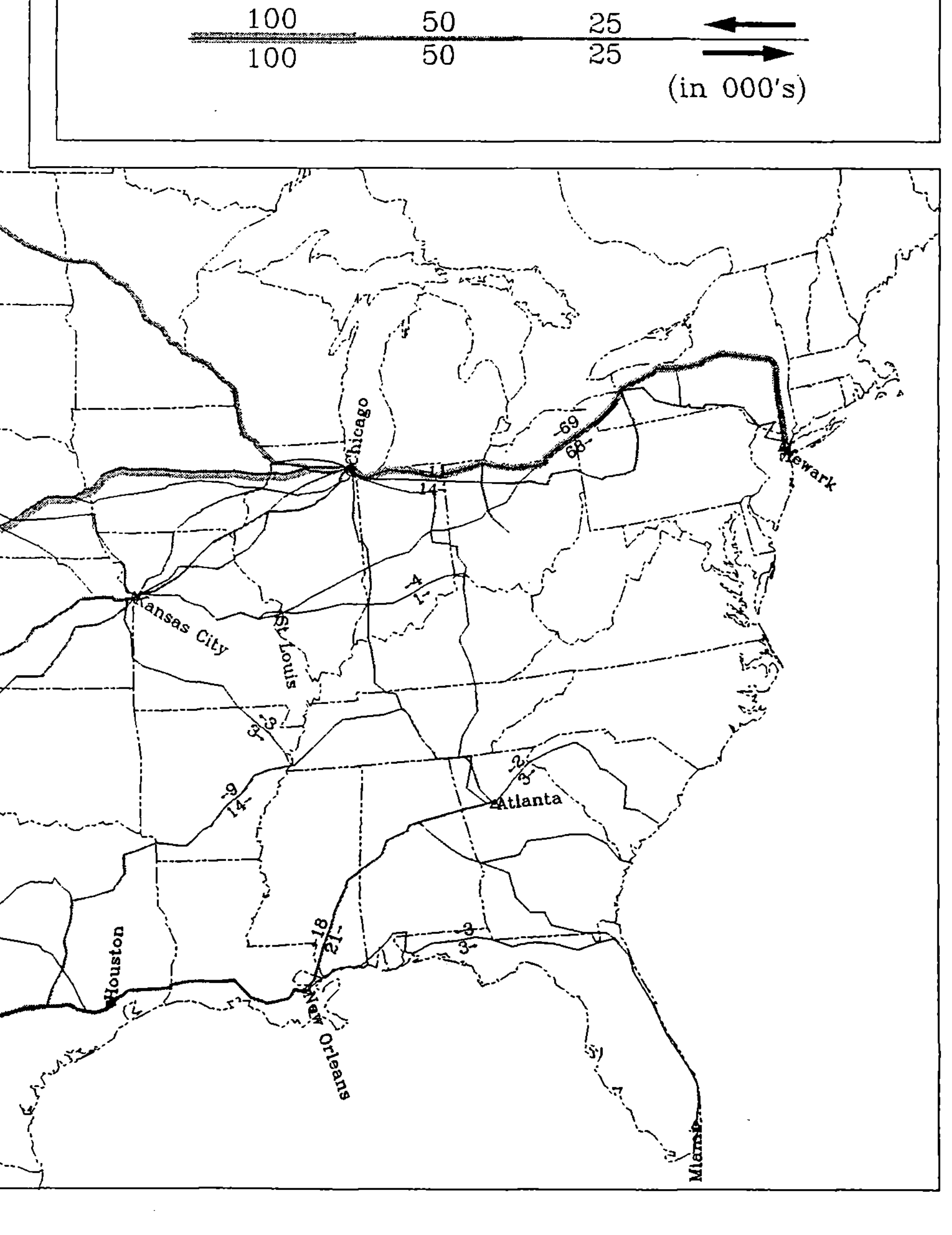
Identifiable Double-Stack Flows. Figure 2 shows the 1987 double-stack traffic flows that could be identified from the Carload Waybill Sample. As explained, an unknown portion of the other container traffic also moves on double-stack cars. Nonetheless, the movement pattern shown in Figure 2 closely matches the major 1987 double-stack operations. The three major western rail corridors each handled substantial double-stack volumes. The Burlington Northern handled double-stack traffic between Seattle/Tacoma and Chicago, and to a lesser extent between Seattle/Tacoma and Kansas City or Memphis. Union Pacific's double-stack traffic from all these west coast port regions oves through the Central Corridor to Chicago via CNW. Southern Pacific moves large volumes on the Southern Corridor between Los Angeles and points in the South, Gulf, and Midwest.

Container Flows. Figure 3 combines all container flows, including those identified as double-stacks in Figure 2. As expected, the overall flow pattern closely resembles the double-stack pattern. Aside from the higher unit counts on all routes, the major difference is the presence of significant COFC flows in secondary markets where, as of 1987, double-stack services had not penetrated. Double-stack services were extended to several of these markets in 1988 and 1989. Overall, 42 percent of the unit-miles in flows shown in Figure 3 were identified as double-stacks in Figure 2.

Trailer Flows. The pattern of trailer flows shown in Figure 4 is markedly different from the pattern of container flows. Most obvious are the much greater participation of Santa Fe in TOFC traffic, and the heavy volume on Conrail. In fact, Figure 4 vividly portrays the long-standing cooperation of Santa Fe and Conrail on east-west transcontinental TOFC movements. A second major difference is the much greater north-south traffic, particularly in the Midwest and Southeast. Routes such as Chicago-Dallas (which received double-stack service in December of 1988) carried far more trailers than containers in 1987.


Seattle
Oakland
Los Angeles
Salt Lake Cit
-11
45-
-3
3-
-38
128-
-26
25-
-33
31-
-22
20-
-4
6-
Figure 2

Double Stack Container Flows
Data Source: 1987 ICC Carload Waybill Sample
Total Unit-Miles: 1,305,568,743



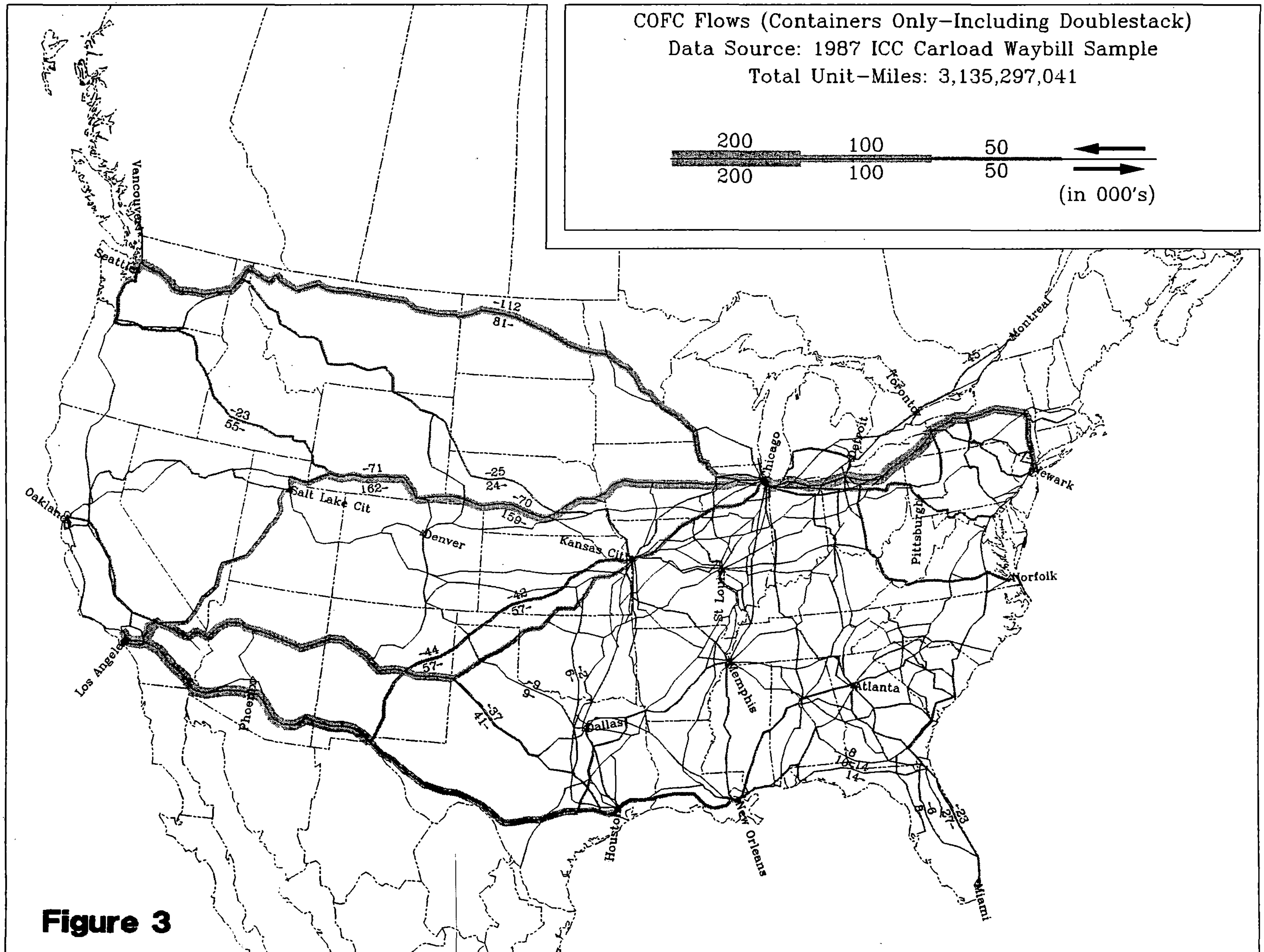

COFC Flows (Containers Only–Including Doublestack)
Data Source: 1987 ICC Carload Waybill Sample
Total Unit–Miles: 3,135,297,041
200
200
100
100
50
50
(in 000's)
Vancouver
Seattle
Oakland
Los Angeles
Phoenix
Salt Lake Cit
Denver
Kansas Cit
St Louis
Chicago
Detroit
Toronto
Montreal
Newark
Pittsburgh
Norfolk
Memphis
Atlanta
Dallas
Houston
New Orleans
Miami
112
81
23
55
71
162
25
24
70
159
42
57
44
57
37
41
9
9
45

Figure 3

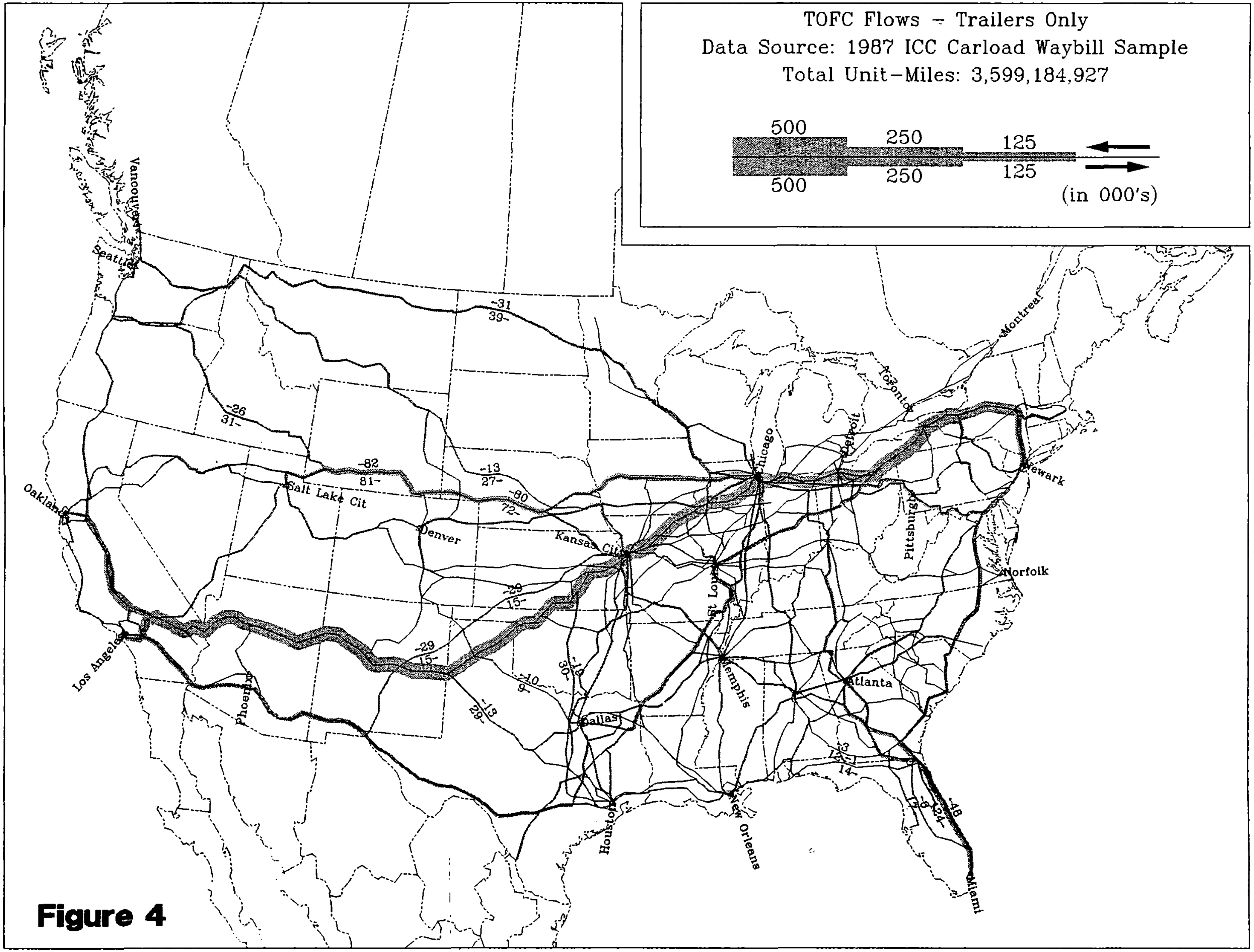

TOFC Flows – Trailers Only
Data Source: 1987 ICC Carload Waybill Sample
Total Unit–Miles: 3,599,184,927
500
250
125
500
250
125
(in 000's)
Vancouver
Seattle
Oakland
Los Angeles
Phoenix
Salt Lake Cit
Denver
Kansas Cit
Chicago
Detroit
Toronto
Montreal
Newark
Pittsburgh
Norfolk
St Louis
Memphis
Atlanta
Dallas
Houston
New Orleans
Miami

Figure 4

Total Intermodal Flows. Figure 5 combines the TOFC and COFC data to illustrate the overall pattern of rail intermodal movement. As expected, 1987 intermodal traffic was concentrated on long hauls between major population centers and hubs. Figure 5 places the eastern and western railroads in much different postures. In the East, with the exception of Conrail's major route, intermodal volumes are diffused over the network. In the West, intermodal volumes are concentrated on the transcontinental mainlines, giving the appearance of a tree-like structure. Overall, the national pattern is hub-and-spoke, with the western spokes being much longer.

Carload Traffic Data. The first step in selecting the carload traffic of interest is to define "boxcar" traffic. In contemplating the diversion of "merchandise" traffic from general-purpose boxcars and refrigerator cars to general-purpose dry and refrigerator containers, it is desirable to eliminate bulk loading, exceptionally heavy or dirty commodities, and some traffic carried in specialized boxcars. The UMLER/AAR cartype code restrictions listed in Appendix Table 1 achieve that purpose. Standard transportation commodity code restrictions are given in Appendix Table 2.

It was assumed that all of these commodities would be carried in dry containers or self-contained refrigerator containers 48 feet long, 102 inches wide, and 9 feet 6 inches high. These are the dimensions of the 48-foot containers used by most companies for domestic traffic. A dry container of this size has a tare weight of about 8100 pounds and a capacity of 3450 cubic feet. A notional self-contained (i.e. with generator set) refrigerator container of this size would weigh about 13,100 pounds (allowing 5000 pounds for genset and refrigeration equipment, typical of Canadian self-contained reefers) and would have a capacity of about 2950 cubic feet (losing about 500 cubic feet to refrigeration equipment).

Actual loading of such containers is further restricted by rail and highway weight limits and by imperfect packing or stowage. Some carriers limit loading in 48-foot containers to 48,000 pounds to allow for a variety of chassis weights and to meet highway limits, which are more stringent than rail limits. The corresponding reefer limit would be 43,000 pounds. Historic trade data show an average container cubic utilization of 80

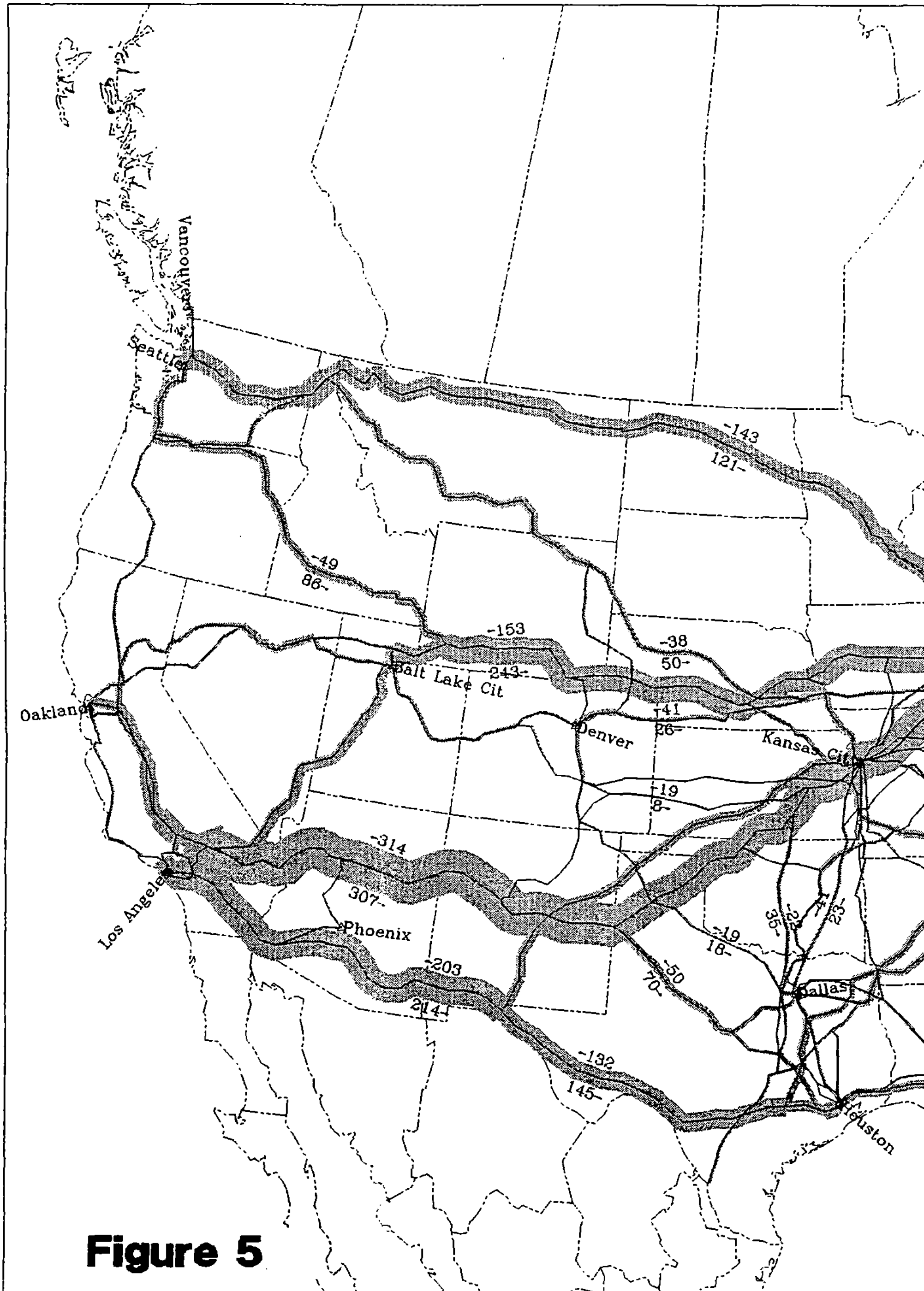
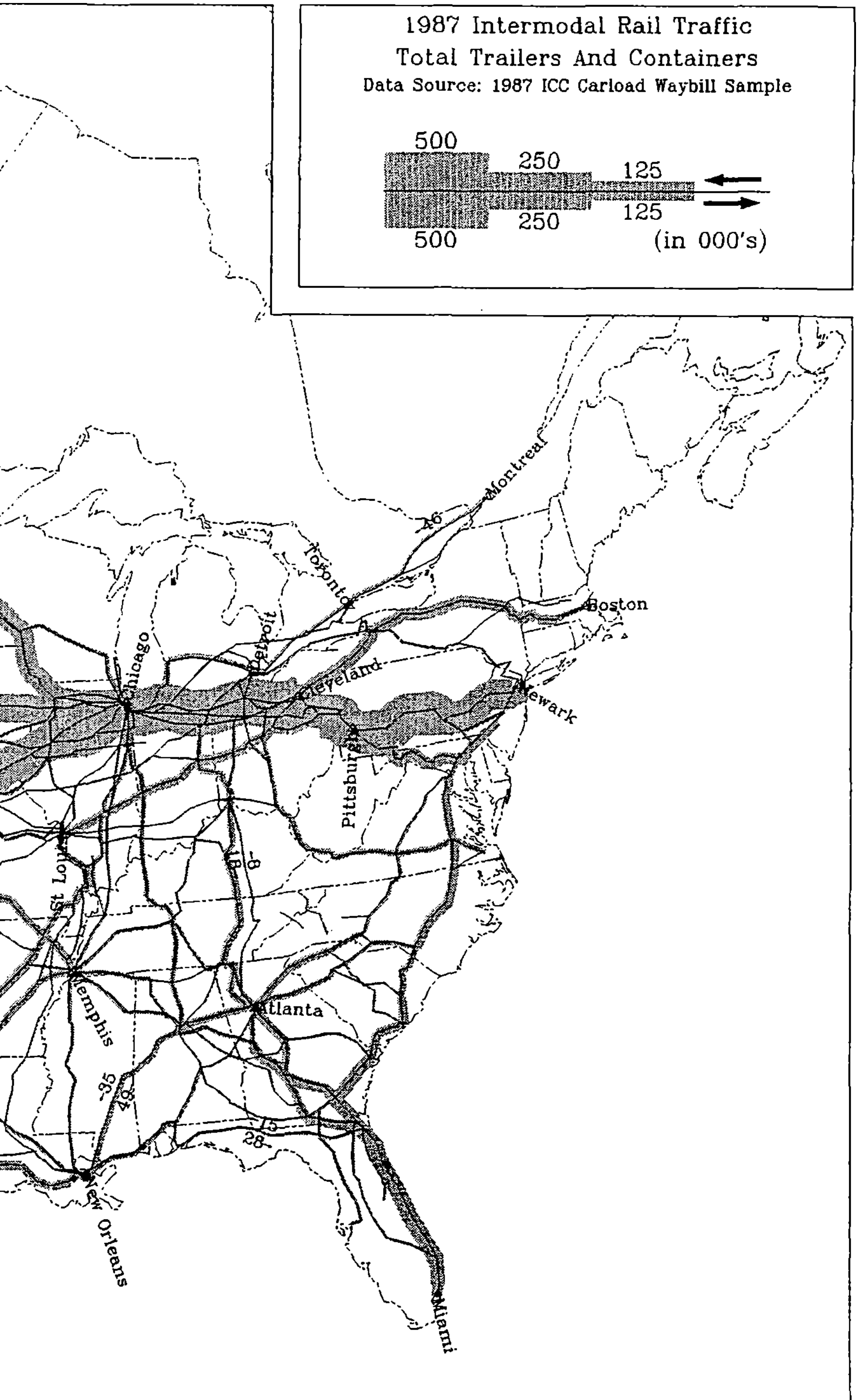

Vancouver
Seattle
Oakland
Los Angeles
Salt Lake Cit
Denver
Kansas Cit
Phoenix
Dallas
Houston
-143
121-
-49
86-
-153
243-
-38
50-
41
26-
-19
8-
-314
307-
-203
214-
-19
18-
-50
70-
-132
145-
35-
23-

Figure 5


1987 Intermodal Rail Traffic
Total Trailers And Containers
Data Source: 1987 ICC Carload Waybill Sample
500
250
125
125
250
500
(in 000's)
Montreal
46
Toronto
Boston
Detroit
Chicago
Cleveland
Newark
Pittsburgh
18
8
Memphis
Atlanta
35
49
15
28
New Orleans
Miami

percent, meaning that, on average, 20 percent of the cubic capacity is used for dunnage or bracing, or is wasted due to an inexact fit of commodity packages or pallets. Thus, the practical loading limits are as follows:

Container	Weight Capacity	Cubic Capacity
48-foot dry	48,000 lbs.	2760 cu ft.
48-foot reefer	43,000 lbs.	2360 cu ft.

Only a few commodities are cube-limited: tobacco, furniture, rubber and plastic goods, glass, pottery, electrical machinery (appliances), instruments, and empty containers. Choosing a large domestic container with a higher tare produced a liberal estimate of container equivalents for weight-limited commodities. Thus, the estimate of container equivalents for boxcar commodities tends toward the upper bound.

Selected Boxcar Flows. The commodity-by-commodity selection process results in the boxcar flows illustrated in Figure 6. The unit-mile total in 1987 was 3,527,253,072 -- very close to the TOFC total. Figure 6 shows, however, that the boxcar traffic flows are much more diffuse, particularly in the lower Midwest and Southeast. The boxcar flows show the importance of lumber, paper, and auto parts, which move in different corridors than existing intermodal traffic.

Combined Intermodal and Boxcar Traffic. All of the rail traffic selected for analysis in this study is shown in Figure 7. This figure can be most succinctly described as a U.S. rail map with long-haul intermodal flows highlighted and coal and grain flows deleted. Major origin and destination hubs that stand out include Seattle, Portland, Oakland, Los Angeles, Kansas City, St. Louis, Chicago, Dallas, Houston, New Orleans, Memphis, Detroit, Atlanta, Miami, Philadelphia, New York, and Boston. All of the largest rail systems are well-represented, but some of the regionals such as SOO, KCS, ICG, and the Guilford System are not. Due to its heavy Jacksonville-Miami intermodal traffic, the Florida East Coast is quite prominent.

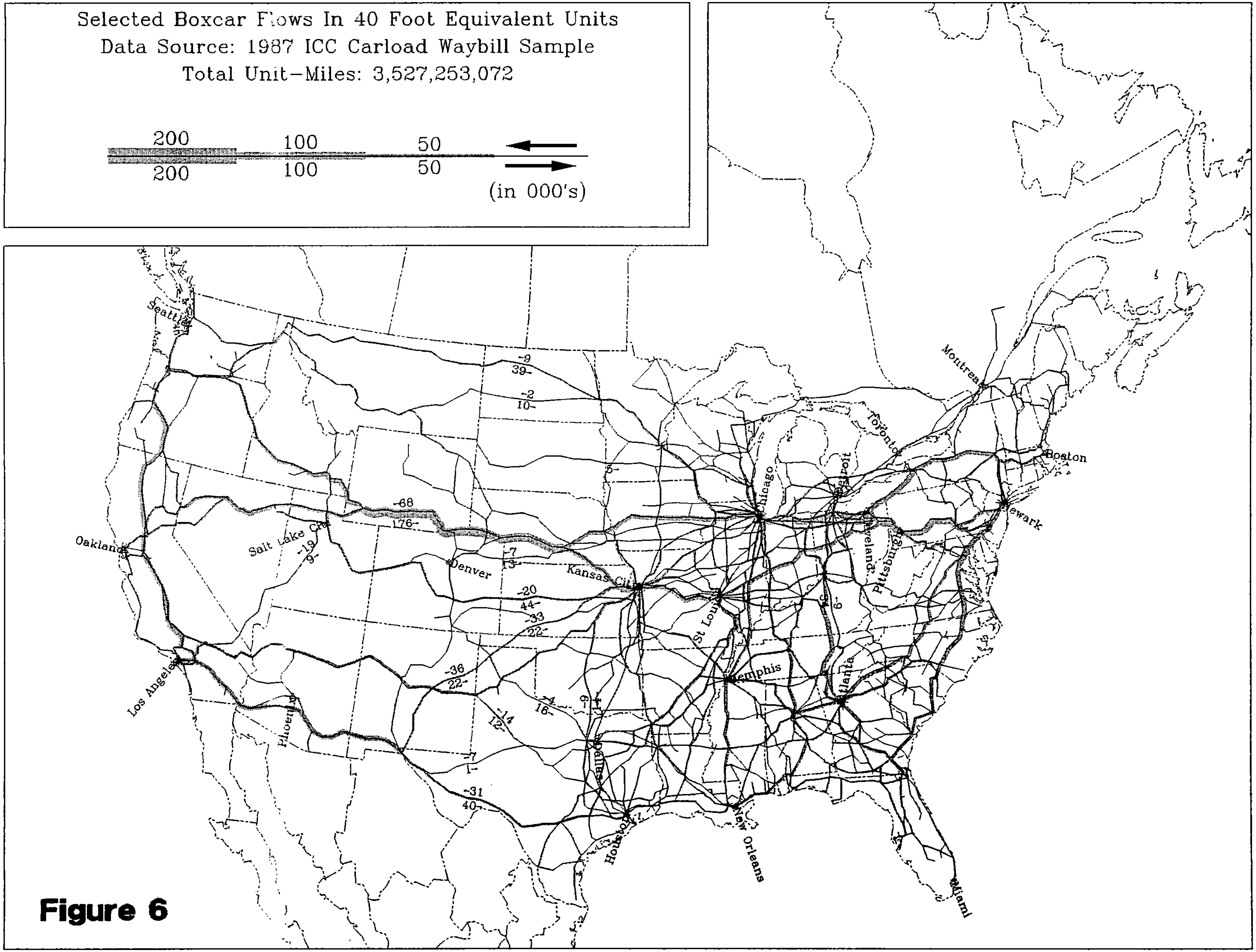

Selected Boxcar Flows In 40 Foot Equivalent Units
Data Source: 1987 ICC Carload Waybill Sample
Total Unit-Miles: 3,527,253,072
200
200
100
100
50
50
(in 000's)
Seattle
Oakland
Los Angeles
Salt Lake City
Phoenix
Denver
Kansas City
Dallas
Houston
Chicago
St Louis
Memphis
New Orleans
Detroit
Toronto
Montreal
Cleveland
Pittsburgh
Atlanta
Boston
Newark
Miami
-9
39-
-2
10-
-68
176-
-19
9-
-7
13-
-20
44-
-33
22-
-36
22-
-14
12-
-4
16-
-7
1-
-31
40-

Figure 6

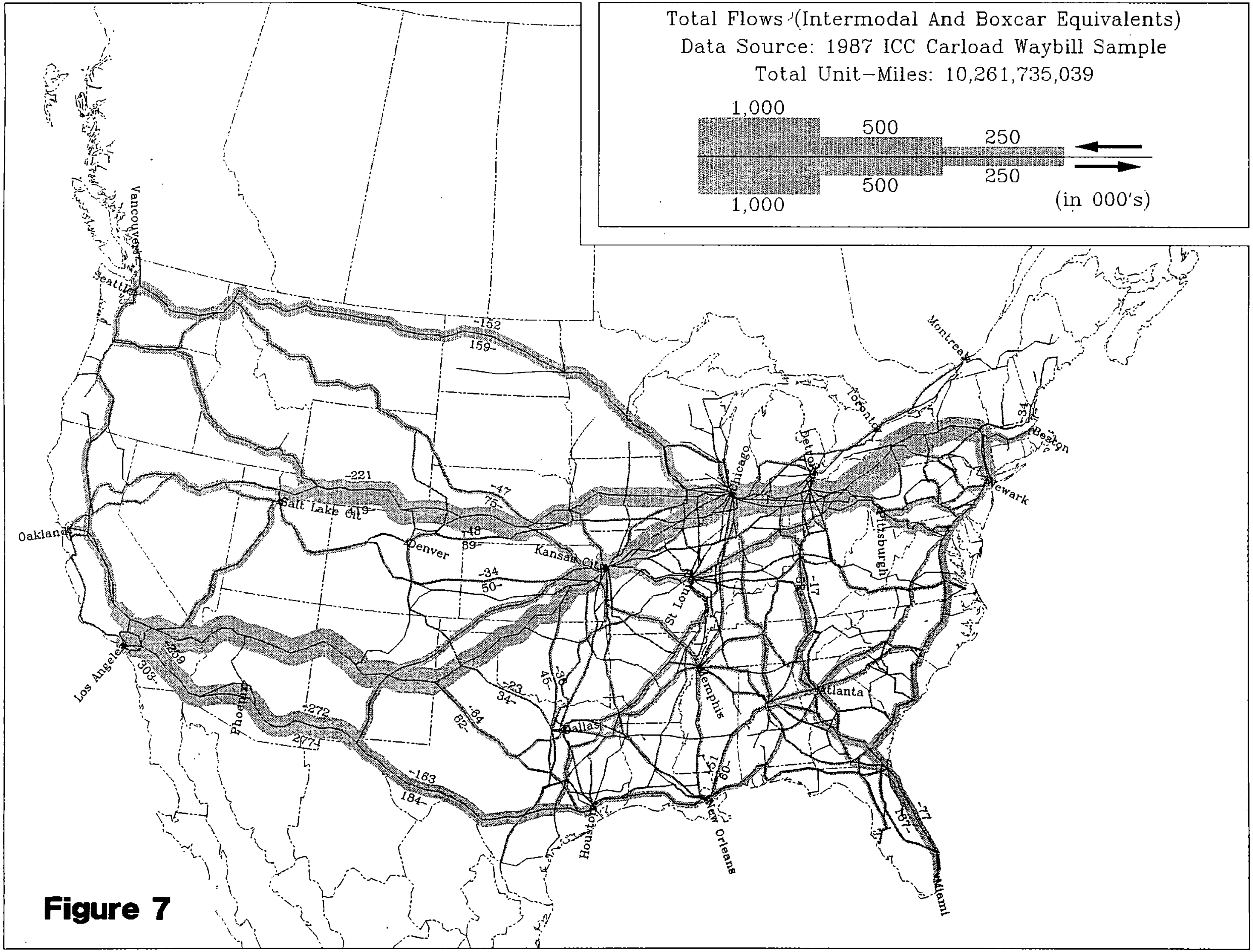

Total Flows (Intermodal And Boxcar Equivalents)
Data Source: 1987 ICC Carload Waybill Sample
Total Unit-Miles: 10,261,735,039
1,000
500
250
250
500
1,000
(in 000's)
Vancouver
Seattle
Oakland
Los Angeles
Phoenix
Salt Lake Cit
Denver
Kansas City
Dallas
Houston
New Orleans
Memphis
St Louis
Chicago
Detroit
Toronto
Montreal
Boston
Newark
Pittsburgh
Atlanta
Miami
-152
159-
-221
-47
75-
-48
89-
-34
50-
-23
34-
-64
82-
-272
277-
-183
184-
308-
45-
-36
-17
-77

Figure 7

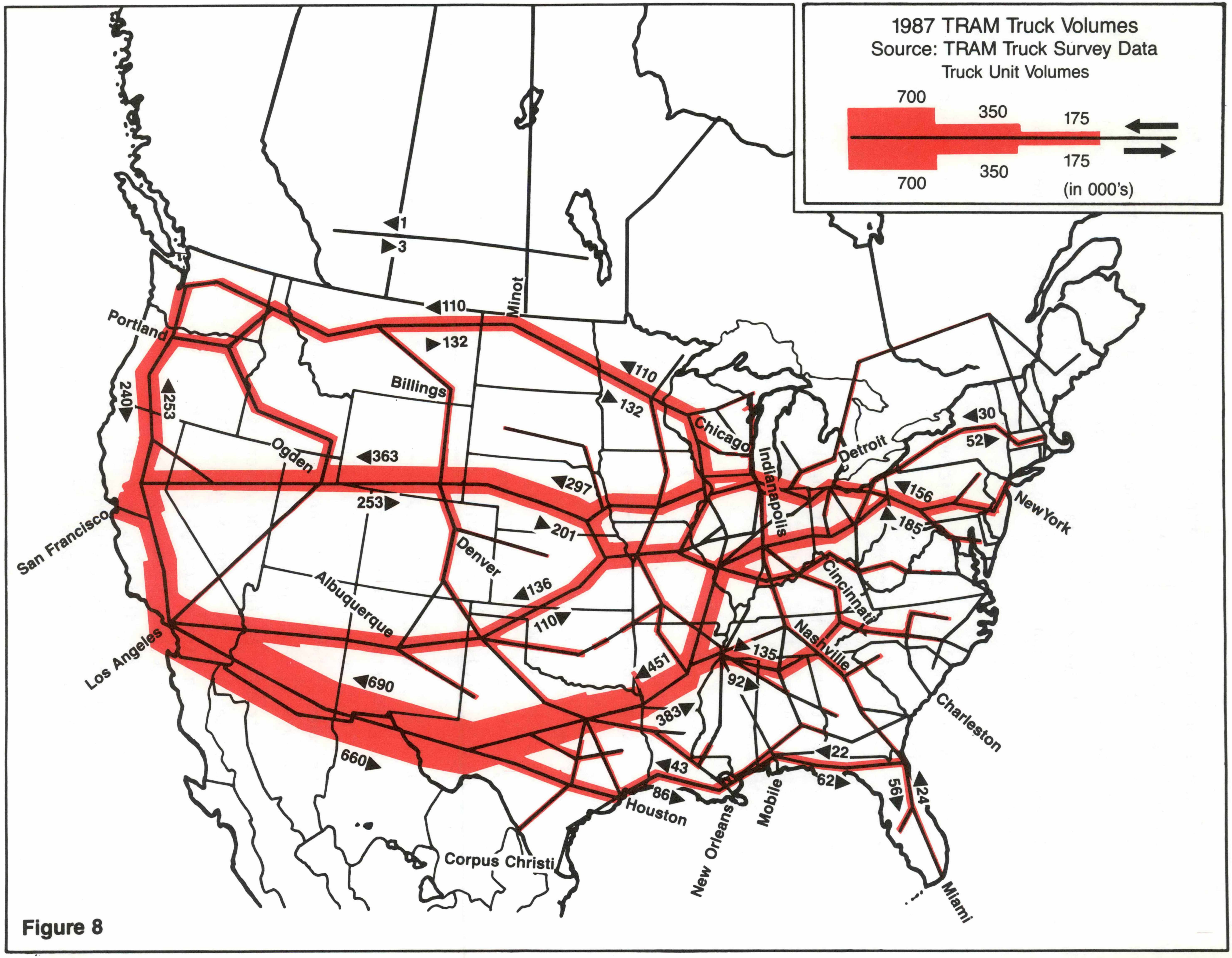
2. Transcontinental Truck Traffic

Data Source. There is only one current database of motor container movements: the National Motor Transport Data Base (NMTDB), maintained by Transportation Research and Marketing (TRAM). For the past 13 years, the NMTDB has generated two basic data sets: answers to more than 60 questions asked in one-on-one interviews in selected truckstops; and passing counts of heavy trucks taken by fleet type and trailer type on interstate highways at or near interview locations. Each year, TRAM compiles 23,000 to 25,000 in-depth surveys and nearly 800 passing counts.

Interviews are currently being conducted at 19 points. At least 80 intercity drivers are interviewed each month at each location. At those locations where more than 120,000 passings occur, one interview is completed for every 1,500 trucks passing. Random interviews are conducted at all hours of the day and night, and at all times of the month. The NMTDB also uses 21 four-hour heavy truck passing counts taken randomly over a continuous seven-day period twice a year. Each passing truck is counted by type of carrier operation (private, regular route, or irregular route), by type of trailing unit (flat, van, refrigerated, drop frame, moving van, etc.) and by direction. All trailer types are specifically tabulated. The 21 four-hour period counts are then projected to weekly data, and estimated 30-day passing counts are developed.

TRAM selected the most comparable and useful format for 1987 data, and selected the relevant portions of the NMTDB. In order to maximize the sample size for this project, TRAM combined the results of the 1985, 1986, and 1987 interviews. For the initial phase of this study, TRAM identified that segment of truck traffic for which rail intermodal services are presently competing with some sign of success. The rail data in Figure 5 show quite clearly that the greatest strength of intermodal service is in transcontinental east-west traffic.

The truck traffic for which these major intermodal services compete was selected from the NMTDB. As shown in Figure 8, this includes dry van and refrigerated (reefer) movements to and from the two westernmost regions: California and Oregon/Washington. To identify such traffic, passing counts



1987 TRAM Truck Volumes
Source: TRAM Truck Survey Data
Truck Unit Volumes
700
350
175
175
350
700
(in 000's)
1
3
110
Minot
132
Portland
110
Billings
132
240
253
Ogden
363
Chicago
Indianapolis
Detroit
30
52
297
253
156
185
New York
San Francisco
201
Denver
Cincinnati
136
Albuquerque
110
Nashville
135
Los Angeles
451
690
92
Charleston
383
660
43
22
86
62
56
24
Houston
Mobile
New Orleans
Corpus Christi
Miami

Figure 8

and survey data was used from three sites: Rock Springs, Wyoming (Interstate 80); Eloy, Arizona (Interstate 10); and Gallup, New Mexico (Interstate 40). Relevant traffic on the northernmost route (Interstate 90 and 94) was investigated but found to be negligible. To account for north-south traffic between California and Oregon/Washington, passing count and interview information from Redding, California (Interstate 5) was also used.

Initial data compilation was restricted to dry vans of truckload carriers. Upon review of the data and further investigation, it was determined that refrigerated (reefer) movements should also be considered because:

- although existing refrigerated container service by rail is minimal, technical and commercial approaches are being actively pursued; and

- from NMTDB interview data, it appears that about 50 percent of the westbound movements (commonly considered to be backhauls) carry non-temperature-sensitive freight.

The refrigerated freight market therefore appears to be accessible, and is apparently intertwined with the dry freight market. Accordingly, reefer passing counts and interviews for reefers from the same sites (Rock Springs, Eloy, Gallup, and Redding) were compiled.

Table 1 shows annualized estimated dry van and reefer truck flows to and from west coast states through each of the four sites. As the tables show, the majority of transcontinental California truck traffic moves over the southern routes, Interstate 10 and Interstate 40. This concentration of truck traffic on the southern routes matches the concentration of rail intermodal traffic on the Southern Corridor. Both traffic concentrations are attributable to the large Southern California population, the large amount of foreign trade through Southern California ports, and the massive agricultural production of the Southern California growing areas. The role of agricultural commodities is especially apparent in the greater number of refrigerated trucks. Even within the dry van category, agricultural and food products account for roughly 20 percent of the eastbound loads. As

Table 1

RELEVANT TRANSCONTINENTAL TRUCK TRAFFIC
ANNUAL VOLUME ESTIMATES

TO AND FROM CALIFORNIA:

Via	East/Southbound	West/Northbound	Total
DRY VANS			
Rock Springs	86,472	78,960	165,432
Eloy	212,748	189,396	402,144
Gallup	209,016	286,299	495,315
Redding	173,364	201,156	374,520
Subtotal	681,600	755,811	1,437,411
REFRIGERATED VANS			
Rock Springs	76,308	95,736	172,044
Eloy	277,704	277,500	555,204
Gallup	197,256	205,716	402,972
Redding	114,420	155,844	270,264
Subtotal	665,688	734,796	1,400,484
CALIFORNIA TOTAL	1,347,288	1,490,607	2,837,895

TO AND FROM OREGON AND WASHINGTON:

Dry Vans			
Rock Springs	67,080	79,128	146,208
Refrigerated Vans			
Rock Springs	91,572	68,316	159,888
Subtotal	158,652	147,444	306,096
WEST COAST TOTAL	1,505,940	1,638,051	3,143,991

expected, Oregon/Washington dry van and reefer totals are much smaller than those for California. For Oregon and Washington dry vans exceed reefers. The eastbound and westbound (or northbound and southbound) truck traffic totals are very closely balanced, especially compared to rail intermodal traffic. For all practical purposes, truckers do not make empty transcontinental trips.

3. Rail and Truck Traffic Flows

Rail/Truck Comparisons. The rail and truck data were combined on the same geographic basis. The rail and truck data are given in Table 2, each in units and net tons. The rail data include trailers, containers, and selected boxcar movements. The flows originating in the Northwest and in California show more total rail tons than truck tons, largely a consequence of including selected boxcar traffic (namely lumber, paper, and other forest products). Westbound rail flows from the Upper Midwest (which includes Chicago) exceed truck flows, and by a large margin to the Northwest; the other westbound flows are dominated by trucks. Overall domination by trucks is consistent with national market shares and long-standing trends. The much greater rail penetration of the Upper Midwest-to-Northwest market is likely due to the increase in exports through Northwest ports, and the effectiveness of double-stack backhaul solicitation. Table 2 also shows clearly that refrigerated truck movements would be a major potential market for double-stack service _if_ a highly reliable and cost-effective system for double-stack refrigeration can be developed.

Traffic Patterns. Figure 7 showed the rail traffic flows previously identified as being relevant to the study. Figure 8 showed the long-haul, inter-regional truck flows, previously identified as likely to be relevant, allocated to the same rail corridors. (Neither map shows the volumes associated with individual railroads or their routes.) Some features are immediately apparent. First, the major intermodal routes in the western states correspond closely to the major truck flows. Second, relatively little truck traffic shows up in the eastern rail corridors. Third, rail intermodal traffic is heavily concentrated in a few midwestern hubs, notably Chicago, while truck traffic is more diffuse. The truck corridor between Chicago and New York would be much denser if truck traffic, like rail traffic, were funneled through the Chicago gateway.

COMPARISON OF TRUCK VERSUS RAIL DATA BY TRAM REGION
TRUCK DATA SOURCE: TRAM MONTHLY SURVEY EXPANDED TO ANNUALIZED VOLUMES
RAIL DATA SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE INTERMODAL AND BOXCAR EQUIVALENTS

		TRAM TRUCK DATA				RAIL DATA	
		TRAM 12 MO DRY VANS		TRAM 12 MO REFERS		EXPANDED 1987 WAYBILL	
ORIGIN REGION	DESTINATION REGION	UNITS	NET TONS	UNITS	NET TONS	UNITS	NET TONS
NORTHWEST	NORTHWEST	0	0	0	0	68,936	1,210,996
NORTHWEST	CALIFORNIA	135,585	2,420,471	82,240	1,718,670	113,157	2,610,116
NORTHWEST	MOUNTAIN STATES	13,176	245,514	15,956	311,240	38,173	779,504
NORTHWEST	LOWER MIDWEST	17,019	291,443	34,759	727,747	67,343	1,342,680
NORTHWEST	UPPER MIDWEST	23,058	440,471	32,976	665,521	212,520	3,802,870
NORTHWEST	SOUTHEAST	3,294	60,116	15,061	315,455	33,113	697,000
NORTHWEST	MID ATLANTIC	8,784	150,100	22,394	444,393	34,559	662,748
NORTHWEST	NORTHEAST	12,627	231,517	39,785	784,311	57,684	1,202,320
NORTHWEST	....	213,543	3,839,632	243,171	4,967,337	625,485	12,308,234
CALIFORNIA	NORTHWEST	117,990	1,987,463	96,074	1,948,997	30,084	526,852
CALIFORNIA	CALIFORNIA	15,934	232,745	7,643	140,277	52,573	1,013,436
CALIFORNIA	MOUNTAIN STATES	63,174	910,025	47,458	937,810	69,591	1,265,824
CALIFORNIA	LOWER MIDWEST	194,756	3,008,522	110,758	2,162,383	228,064	3,955,670
CALIFORNIA	UPPER MIDWEST	121,283	1,972,826	98,915	1,964,981	365,737	6,149,001
CALIFORNIA	SOUTHEAST	74,350	1,196,358	59,427	1,206,014	56,719	1,028,384
CALIFORNIA	MID ATLANTIC	55,710	988,916	54,733	1,112,632	67,246	1,175,968
CALIFORNIA	NORTHEAST	95,494	1,441,512	123,383	2,450,214	78,218	1,447,840
CALIFORNIA	....	738,691	11,738,367	598,391	11,923,308	948,232	16,562,975
MOUNTAIN STATES	NORTHWEST	9,882	175,436	24,589	488,798	38,040	739,228
MOUNTAIN STATES	CALIFORNIA	39,138	674,799	62,607	1,245,586	50,123	928,742
MOUNTAIN STATES	....	49,020	850,235	87,196	1,734,384	88,163	1,667,970
LOWER MIDWEST	NORTHWEST	29,646	421,526	54,779	1,071,046	45,666	721,920
LOWER MIDWEST	CALIFORNIA	164,085	2,497,525	158,711	3,135,054	240,903	4,391,051
LOWER MIDWEST	....	193,731	2,919,051	213,490	4,206,100	286,569	5,112,971
UPPER MIDWEST	NORTHWEST	21,960	325,919	36,915	664,213	179,845	2,009,472
UPPER MIDWEST	CALIFORNIA	153,466	2,290,970	131,264	2,455,447	337,463	5,251,848
UPPER MIDWEST	....	175,426	2,616,889	168,179	3,119,660	517,308	7,261,320
SOUTHEAST	NORTHWEST	5,490	106,919	12,183	218,805	12,608	225,280
SOUTHEAST	CALIFORNIA	61,031	984,150	46,856	852,233	38,968	725,373

Table 2

COMPARISON OF TRUCK VERSUS RAIL DATA BY TRAM REGION
TRUCK DATA SOURCE: TRAM MONTHLY SURVEY EXPANDED TO ANNUALIZED VOLUMES
RAIL DATA SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE INTERMODAL AND BOXCAR EQUIVALENTS

		TRAM TRUCK DATA				RAIL DATA	
		TRAM 12 MO DRY VANS		TRAM 12 MO REFERS		EXPANDED 1987 WAYBILL	
ORIGIN REGION	DESTINATION REGION	UNITS	NET TONS	UNITS	NET TONS	UNITS	NET TONS
SOUTHEAST	....	66,521	1,091,069	59,039	1,071,038	51,576	950,653
MID ATLANTIC	NORTHWEST	13,725	181,365	25,534	427,429	21,586	285,720
MID ATLANTIC	CALIFORNIA	94,375	1,454,312	75,508	1,218,668	63,242	1,015,620
MID ATLANTIC	....	108,100	1,635,677	101,042	1,646,097	84,828	1,301,340
NORTHEAST	NORTHWEST	9,333	124,734	26,167	447,267	4,798	76,620
NORTHEAST	CALIFORNIA	93,738	1,370,624	97,639	1,719,253	37,112	554,040
NORTHEAST	....	103,071	1,495,358	123,806	2,166,520	41,910	630,660
....	....	1,648,103	26,186,278	1,594,314	30,834,444	2,644,071	45,796,123

Table 2

Figure 9 presents rail and truck traffic volumes on the same scale. The funneling of rail traffic and the diffusion of truck traffic are both immediately apparent. It is also apparent from Figure 9 that rail intermodal services have achieved (or could achieve, in the case of relevant boxcar traffic) a significant share of the transcontinental market in the western states.

In the northernmost corridor, rail has the major share. This interpretation is consistent with NMTDB information from the field, where relevant truck traffic on Interstates 90 and 94 was found to be very light. It must be noted, however, that the Central Corridor serves some of the same traffic flows. In the Central Corridor, rail has more of the eastbound market than of the westbound, which may reflect the rail movements of containerized imports. The Central Corridor branches in Utah (with Union Pacific lines to Southern California and the Pacific Northwest) and in the Midwest (with Union Pacific and SP/DRGW routes to Kansas City and St. Louis), making its flows considerably more complex.

There has also been significant market penetration in the Southern Corridor, notably in the Chicago-Los Angeles market. Figure 9 indicates that rail now carries the majority of the relevant traffic. Work by the AAR's Intermodal Policy Division has confirmed that double-stack services have indeed diverted substantial truck traffic in the major corridors. Figure 9 suggests, however, that there are large truck flows moving over Interstate 10 to and from California (and observed at the Eloy, Arizona collection point) in which there has been relatively little rail intermodal penetration. Both rail and truck flows branch out from this corridor, with the larger flow serving the Midwest and points east.

The general match between rail and truck flows in Figure 9 confirms the relevance of the selected truck flows for competition with existing intermodal services.

<u>Traffic Balance</u>. One recurring issue in intermodal transportation of all kinds, especially double-stack movements, is traffic balance. Table 3 shows the ratios between eastbound and westbound units for dry vans, reefer vans, and rail. Ratios near 1.0 (ranging perhaps from 0.8 to 1.2) indicate

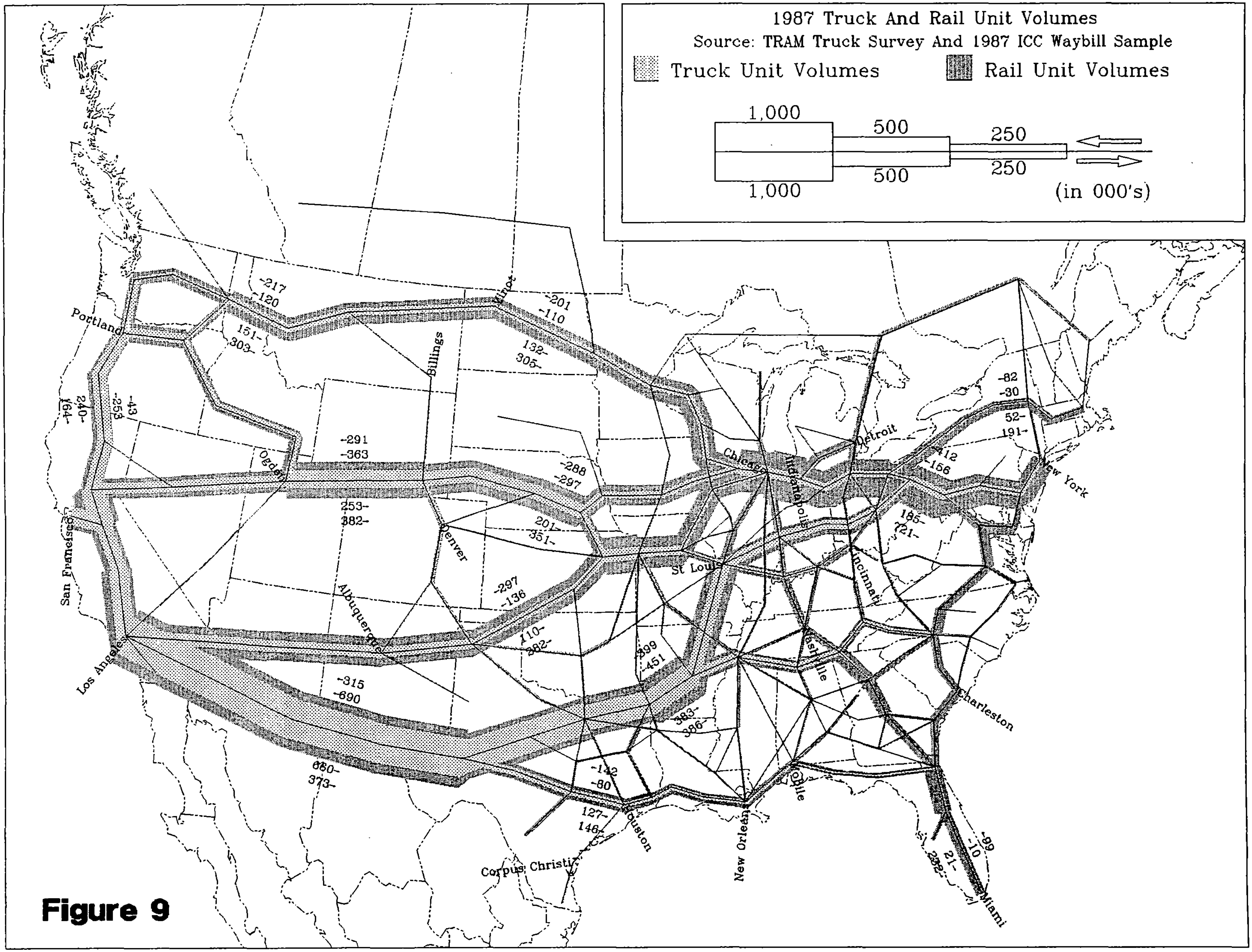

1987 Truck And Rail Unit Volumes
Source: TRAM Truck Survey And 1987 ICC Waybill Sample
Truck Unit Volumes
Rail Unit Volumes
1,000
500
250
(in 000's)
Portland
San Francisco
Los Angeles
Ogden
Billings
Minot
Denver
Albuquerque
Chicago
Detroit
Indianapolis
St Louis
Cincinnati
Nashville
Charleston
New York
Houston
Corpus Christi
New Orleans
Mobile
Miami

Figure 9

Table 3

1987 Truck and Rail Traffic Balance Ratios
(Units)

Northwest	Dry Vans Units Eastbound	Dry Vans Units Westbound	Ratio	Reefer Vans Units Eastbound	Reefer Vans Units Westbound	Ratio	Rail Units Eastbound	Rail Units Westbound	Ratio
Mountain States	13,176	9,882	1.3	15,956	24,589	0.6	38,173	38,040	1.0
Lower Midwest	17,019	29,646	0.6	34,759	54,779	0.6	67,343	45,666	1.5
Upper Midwest	23,058	21,960	1.1	32,976	36,915	0.9	212,520	179,845	1.2
Southeast	3,294	5,490	0.6	15,061	12,183	1.2	33,113	12,608	2.6
Mid Atlantic	8,784	13,725	0.6	22,394	25,534	0.9	34,559	21,586	1.6
Northeast	12,627	9,333	1.4	39,785	26,167	1.5	57,684	4,798	12.0
Total	77,958	90,036	0.9	160,931	180,167	0.9	443,392	302,543	1.5
California									
Mountain States	63,174	39,138	1.6	47,458	62,607	0.8	69,591	50,123	1.4
Lower Midwest	194,756	164,085	1.2	110,758	158,711	0.7	228,064	240,903	0.9
Upper Midwest	121,283	153,466	0.8	98,915	131,264	0.8	365,737	337,463	1.1
Southwest	71,350	61,031	1.2	59,427	46,856	1.3	56,719	38,968	1.5
Mid Atlantic	55,710	94,375	0.6	54,733	75,508	0.7	67,246	63,242	1.1
Northeast	95,494	93,738	1.0	123,383	97,639	1.3	78,218	37,112	2.1
Total	601,767	605,833	1.0	494,674	572,585	0.9	865,575	767,811	1.1

relatively close balance between movements in the two directions. As the ratios move farther from 1.0, balance becomes a serious issue. At a ratio of 1.5, 50 percent more units are moving eastbound that are returning westbound.

The ratios indicate that rail traffic flows often have a worse balance problem than truck flows. Four of the six Northwest flows follow this pattern, as does the Northwest total. The California flows are more evenly balanced for both rail and truck. The rail flows between California and the Northwest are severely imbalanced, most likely due to the heavy southbound movements of lumber, paper, and other forest products in boxcars, which then return empty.

Table 3 illustrates what intermodal operators must confront: rail has become the mode of imbalance. Within overall traffic flows that one, by nature, imbalanced, motor carriers have extracted the balanced portion. As noted earlier, truckers do not make empty transcontinental hauls: railroads make them.

4. Oceanborne Freight Movements

Methodology. The Bureau of the Census trade data identifies shipments as being Containerized, Not Containerized, or Unknown (if containerized). For this study, all shipments identified as being containerized were retained, and the containerizable portion of the "Unknown" shipments was estimated using Manalytics' proprietary containerizability factors. Thus, the data presented here consist of those shipments reported by the Bureau of the Census to be containerized, and the portion of unknown shipments estimated to be containerizable.

TEU and FEU Estimates. The Bureau of the Census data give weight information in pounds, which were converted to short tons (2000 pounds) for easy comparison with rail and truck data. The source data do not, however, include either a container count or an indication of container size, so the twenty-foot equivalent units (TEU) and forty-foot equivalent units (FEU) corresponding to the weights reported in the Census data were estimated. The basis for these estimates is Manalytics' proprietary database of historical 20-foot and 40-foot container loadings, which gives conversion factors in tons/TEU and tons/FEU for all of the relevant commodities and trades. It must be emphasized that the TEU and FEU estimates were separately derived: as the tables will reveal, the FEU estimate is not half the TEU estimate.

The twenty-foot equivalents (TEU) and forty-foot equivalents (FEU) shown on the tables should be interpreted as estimates of the number of 20-foot (or 40-foot) containers required to carry the total tonnage. Were the entire movement to be carried in only 20-foot containers (or only 40-foot containers), then the TEU (or FEU) figure would be an estimate of the actual number of containers. Since, the various commodities and trades are carried in a mix of container sizes, neither the TEU estimate nor the FEU estimate can be expected to correspond to the actual container count, which would likely fall somewhere between them. No attempt has been made to account for the variations in size between 35', 40', and 45' containers, or for the difference in 8', 8'6", 9', and 9'6" container heights.

Ports and port groups are defined in Appendix Tables 3 and 4. Some of the major ports (such as New York) include adjacent regional ports (such as Newark, NJ) where the region effectively functions as a single part of origin or destination. The Appendix tables also give an exhaustive list of the countries and 3-digit Census Bureau country codes combined in the six major foreign trade regions used in the table.

Foreign Trade. Appendix Table 5 summarizes the containerized foreign trade data gathered by the Bureau of the Census for 1986 and 1987, in terms of short tons (2000 pounds), twenty-foot equivalent units (TEU) and forty-foot equivalent units (FEU). The first portion aggregates data for the four U.S. coasts (Atlantic, Gulf, Pacific, and Great Lakes) and Hawaii/Alaska/ Puerto Rico. As expected, very little containerized liner cargo moves through the Great Lakes ports. The remaining pages give the traffic volumes at major ports (such as Boston, New York, and Philadelphia) or among major port groups (such as Houston/Galveston and Long Beach/Los Angeles). Minor container ports are grouped into regional categories (such as other Delaware River Ports). Traffic for each port or region is broken down by foreign

Table 4

1987 IMPORT/EXPORT SUMMARY
By Coast and Inland Region

	Import FEUs	Weekly Train Equivalents	Export FEUs	Weekly Train Equivalents
** Atlantic				
California	37929	3.8	2657	0.3
Lower Midwest	17836	1.8	7729	0.8
Mid Atlantic	81992	8.2	115575	11.6
Mountain	4258	0.4	2284	0.2
Northeast	571910	57.2	86542	8.7
Northwest	4994	0.5	1180	0.1
Southeast	89750	9.0	103014	10.3
Upper Midwest	87355	8.7	34095	3.4
** Subtotal **				
	896024	89.6	353076	35.3
** Great Lakes				
California	10	0.0	18	0.0
Lower Midwest	69	0.0	150	0.0
Mid Atlantic	29	0.0	8	0.0
Mountain	1	0.0	137	0.0
Northeast	275	0.0	26	0.0
Northwest	4	0.0	35	0.0
Southeast	17	0.0	17	0.0
Upper Midwest	885	0.1	1735	0.2
** Subtotal **				
	1290	0.1	2126	0.2

Source: Bureau of the Census

Table 4

1987 IMPORT/EXPORT SUMMARY
By Coast and Inland Region

	Import FEUs	Weekly Train Equivalents	Export FEUs	Weekly Train Equivalents
** Gulf				
California	6741	0.7	6190	0.6
Lower Midwest	23824	2.4	92649	9.3
Mid Atlantic	2428	0.2	5607	0.6
Mountain	2725	0.3	4904	0.5
Northeast	30969	3.1	4193	0.4
Northwest	801	0.1	519	0.1
Southeast	43133	4.3	44156	4.4
Upper Midwest	9815	1.0	4991	0.5
** Subtotal **	120436	12.0	163209	16.3
** Pacific				
California	328976	32.9	161752	16.2
Lower Midwest	67382	6.7	53192	5.3
Mid Atlantic	34143	3.4	14604	1.5
Mountain	14975	1.5	21793	2.2
Northeast	294413	29.4	9936	1.0
Northwest	34594	3.5	116182	11.6
Southeast	24308	2.4	15564	1.6
Upper Midwest	153375	15.3	37972	3.8
** Subtotal **	952166	95.2	430995	43.1
*** Total ***	1969916	197.0	949406	94.9

Source: Bureau of the Census

Table 5

1987 IMPORT/EXPORT SUMMARY
By Inland Region and Coast

	Import FEUs	Weekly Train Equivalents	Export FEUs	Weekly Train Equivalents
** California				
Atlantic	37929	3.8	2657	0.3
Great Lakes	10	0.0	18	0.0
Gulf	6741	0.7	6190	0.6
Pacific	328976	32.9	161752	16.2
** Subtotal **	373656	37.4	170617	17.1
** Lower Midwest				
Atlantic	17836	1.8	7729	0.8
Great Lakes	69	0.0	150	0.0
Gulf	23824	2.4	92649	9.3
Pacific	67382	6.7	53192	5.3
** Subtotal **	109111	10.9	153720	15.4
** Mid Atlantic				
Atlantic	81992	8.2	115575	11.6
Great Lakes	29	0.0	8	0.0
Gulf	2428	0.2	5607	0.6
Pacific	34143	3.4	14604	1.5
** Subtotal **	118592	11.9	135794	13.6
** Mountain				
Atlantic	4258	0.4	2284	0.2
Great Lakes	1	0.0	137	0.0
Gulf	2725	0.3	4904	0.5
Pacific	14975	1.5	21793	2.2
** Subtotal **	21959	2.2	29118	2.9

Source: Bureau of the Census

Table 5

1987 IMPORT/EXPORT SUMMARY
By Inland Region and Coast

	Import FEUs	Weekly Train Equivalents	Export FEUs	Weekly Train Equivalents
** Northeast				
Atlantic	571910	57.2	86542	8.7
Great Lakes	275	0.0	26	0.0
Gulf	30969	3.1	4193	0.4
Pacific	294413	29.4	9936	1.0
** Subtotal **				
	897567	89.8	100697	10.1
** Northwest				
Atlantic	4994	0.5	1180	0.1
Great Lakes	4	0.0	35	0.0
Gulf	801	0.1	519	0.1
Pacific	34594	3.5	116182	11.6
** Subtotal **				
	40393	4.0	117916	11.8
** Southeast				
Atlantic	89750	9.0	103014	10.3
Great Lakes	17	0.0	17	0.0
Gulf	43133	4.3	44156	4.4
Pacific	24308	2.4	15564	1.6
** Subtotal **				
	157208	15.7	162751	16.3
** Upper Midwest				
Atlantic	87355	8.7	34095	3.4
Great Lakes	885	0.1	1735	0.2
Gulf	9815	1.0	4991	0.5
Pacific	153375	15.3	37972	3.8
** Subtotal **				
	251430	25.1	78793	7.9
*** Total ***				
	1969916	197.0	949406	94.9

Source: Bureau of the Census

origin (imports) or destination (exports) within the Import and Export categories.

Coastal Trade Shares. Container trade is overwhelmingly dominated by the Atlantic and Pacific coasts, as Appendix Table 5 shows. Atlantic coast ports handled 43 percent of U.S. containerized tonnage, and Pacific ports handled 44 percent. In 1987, the Gulf Coast still received major all-water service from Asia, and handled roughly 12 percent of U.S. containerized tonnage. Withdrawal of those services in late 1988 means that the Gulf Coast container ports will handle primarily South American and Caribbean traffic, with a small flow of European and African cargo. The Great Lakes ports have never participated heavily in container movements, and handled just 0.1 percent of the U.S. total.

The average weight of exports means that U.S. trade as a whole is more strongly imbalanced in containers than in tons:

1987 U.S. Trade

	Import	Export	Ratio
Tons	36,541,819	32,510,919	1.12:1
TEU	4,083,078	2,465,421	1.66:1
FEU	2,206,278	1,539,547	1.43:1

Although the relatively faster growth of exports will eventually balance the container flow, the historic imbalances will persist in the short term. The major drive for double-stack system expansion has come from Pacific Coast container operators in the Far East and Southeast Asia trades which have traditionally been imbalanced in favor of imports. The initial impetus for domestic containerization came from the resultant westbound backhaul capacity.

The overall Coastal FEU balances were as follows:

1987 FEU	Imports	Exports	Excess Imports
Atlantic	984,237	552,533	431,704
Gulf	145,227	249,490	(104,263)
Pacific	1,044,471	714,216	330,255
Great Lakes	1,694	2,795	(1,101)
Hawaii, etc.	30,649	10,513	20,136

Origin/Destination State Data Coverage. One data issue that must be addressed is the completeness and accuracy of origin/destination state information within the Census data. There were many records with no origin or destination state information at all. The invalid and blank state information are combined in an unknown ("??") category. Records with unknown origin or destination states accounted for 22 percent of total U.S. import and export tonnage. The problem is far more serious for exports: records comprising more than a third of U.S. export tonnage have no valid origin state. The biggest problem is exports to East and South Asia, one of the largest and fastest growing U.S. trades, in which more than 40 percent of the tonnage has records with no valid states of origin. Movements via both the Atlantic and Pacific Coasts have similar coverage rates: about 90 percent for imports but only 61-64 percent for exports.

The problem of identifying the origin state for export tonnage is most serious at the largest ports: New York (47% coverage); Baltimore (66% coverage); Charleston (56% coverage); New Orleans (63% coverage); Houston/ Galveston (69% coverage); Long Beach/Los Angeles (59% coverage); Oakland/ San Francisco (66% coverage); and Seattle/Tacoma (60% coverage). In other words, there is no information on the origin state of one-third to one-half the export tonnage at major ports.

Besides the coverage issue, census data shares the "headquarters bias" with other import/export data: the inland origin or destination is often given as a corporate headoffice rather than the actual point of shipment or receipt. This bias leads to uncertainty concerning the actual movement pattern.

Regional and Coastal Summaries. The observations above suggest that a regional, rather than state approach to inland origins and destinations may be useful in understanding the existing pattern and future potential of double-stack service. The major intermodal hubs in Chicago, Kansas City, St. Louis, Memphis, Atlanta, Dallas, Houston, New Orleans, New York, and elsewhere are clearly serving origins and destinations beyond the boundaries of their states. Accordingly, the regions shown in Figure 10 were defined. Each region, with the exception of California, includes two or more states and is grouped around major urban clusters with intermodal hubs. Coast and regional information is summarized in Tables 4 and 5. These tables use FEU and "Weekly Train Equivalents" of 10,000 annual FEU (200 FEU per train, 50 trains per year) to display the underlying pattern of regional and coastal container movements.

B. CURRENT DOUBLE-STACK SERVICES

1. Existing Double-Stack Services

As of December, 1989, there were over 100 weekly eastbound double-stack departures from Southern California, Northern California, and the Pacific Northwest. Until recently, the role of eastern railroads in double-stack operations was to carry west coast trains between mid-continent gateways and eastern destinations. Although continuations of western trains still account for most eastern double-stack traffic, expansion of the double-stack network has led eastern railroads to establish new double-stack trains independent of their western counterparts.

Current Double-Stack Network. The current (late 1989) double-stack network is shown in Figure 11. The combination of routes and hubs shown in Figure 11 yields very extensive national coverage, enabling double-stack trains to serve all major U.S. markets. As Figure 11 illustrates, double-stack operations have begun to resemble a network of interlocking movements rather than a collection of unrelated unit trains. This development has greatly assisted double-stack operators in competing with trucks, because it has created the service frequency and traffic density needed to attract the business of demanding customers. The development of a network has also extended double-stack service to several hubs that

Figure 10
Multi-State Inland Regions

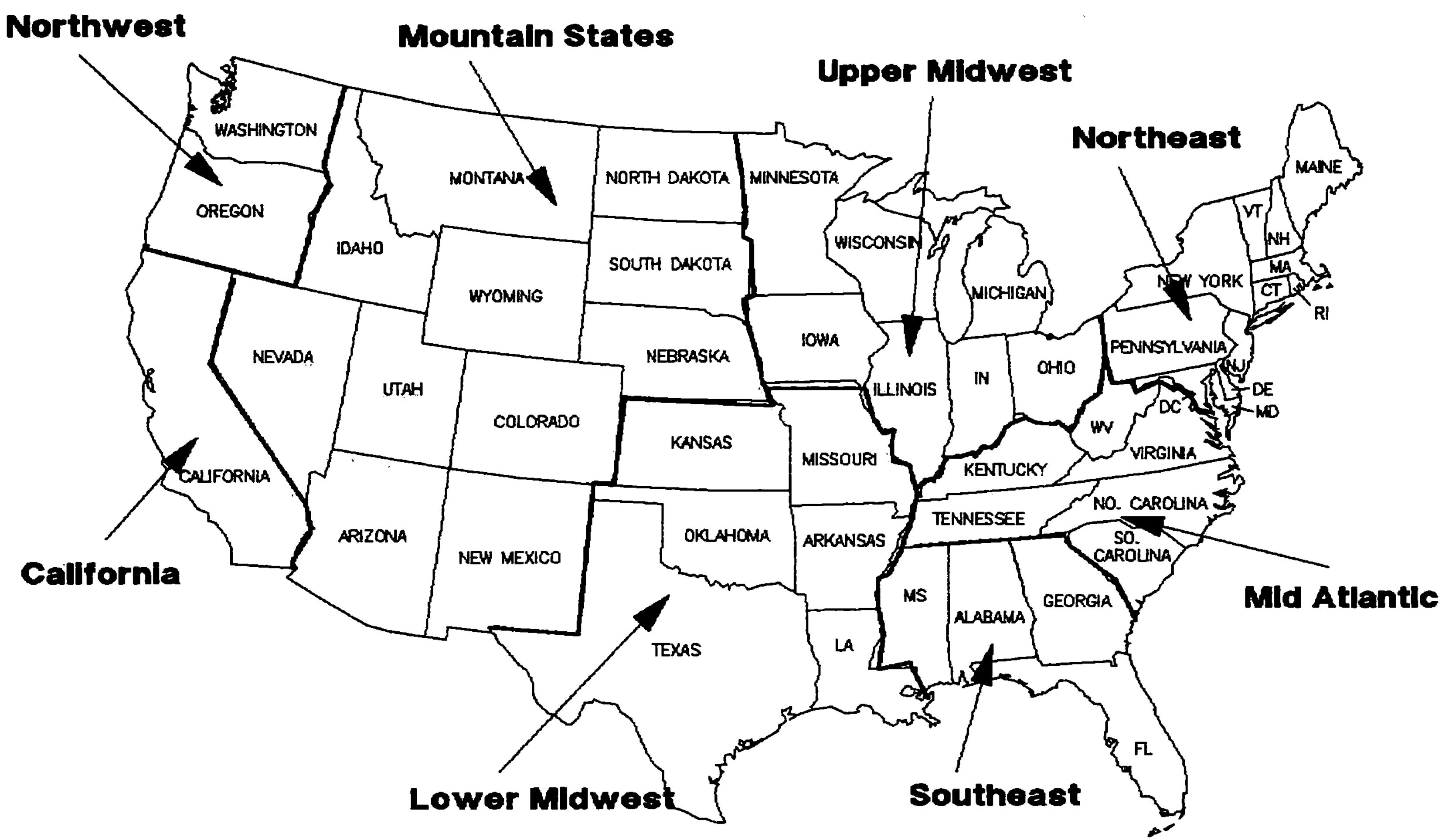
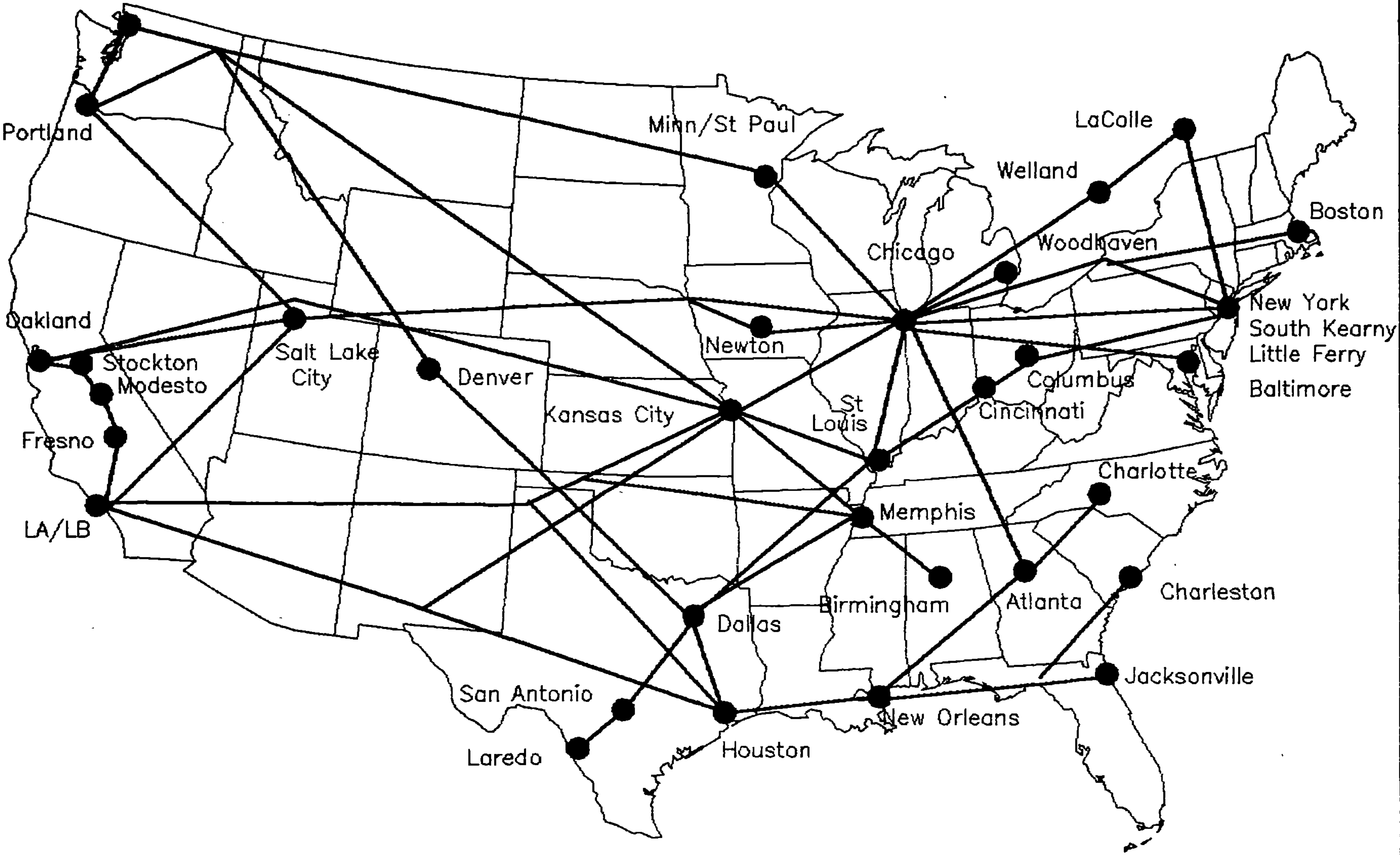


Figure 11

1989 DOUBLE-STACK NETWORK



could not yet support dedicated hub-to-hub unit trains. In late 1989, individual railroads operated the following double-stack services.

<u>Burlington Northern</u>. BN operates both dedicated and common-user double-stack trains to and from the Pacific Northwest ports. The major client for dedicated trains is Sea-Land, while numerous ocean carriers use the common-user trains. BN also serves as a Kansas City - Chicago connection for some SP trains from Southern California, and as a Avard - Memphis connection for Santa Fe.

<u>Santa Fe</u>. Santa Fe currently operates one dedicated Southern California double-stack train, for Hyundai. Departures are weekly from Los Angeles, and Santa Fe moves the train to Chicago. Santa Fe offers several daily intermodal departures from Los Angeles which can and do carry double-stacked containers on a common-user basis. Santa Fe's major traffic lanes are Los Angeles - Chicago and Los Angeles - Houston/Dallas, with service offered to all major intermediate points, notably Kansas City. In Northern California, Santa Fe operates a weekly dedicated train from Richmond for Maersk.

<u>Southern Pacific</u>. SP operates double-stack trains from its Intermodal Container Transfer Facility (ICTF) in Los Angeles. SP currently schedules four daily eastbound common-user double-stack train departures from the ICTF. These trains are destined for Chicago, Memphis, Houston, and interchange with Conrail at St. Louis. Three daily westbound trains to Los Angeles depart from Pine Bluff, New Orleans, and a BN interchange at Kansas City. SP operates a daily dedicated train for Sea-Land to Memphis and three weekly trains to New Orleans and Chicago. There are two dedicated NYK trains from L.A. on SP for St. Louis and Chicago. Mitsui (MOL) has two dedicated departures on SP to serve Chicago, St. Louis, and Memphis. SP operates three weekly dedicated trains from the ICTF for Evergreen for Chicago, New Orleans, and Memphis. On the Southern Corridor, SP originates six weekly trains for American President Intermodal: three operate via Houston to New Orleans for interchange with Norfolk Southern to Atlanta; and three to Memphis via Dallas. SP has thirteen scheduled weekly eastbound departures for ESI, the domestic

subsidiary of OOCL that solicits traffic from other ocean carriers as well.

SP thus schedules about 57 weekly double-stack departures from the Los Angeles ICTF. The actual number of trains may vary depending on which scheduled departures are combined as a single train, and whether heavy traffic requires extra trains for some schedules. While the dedicated trains operated for steamship companies generally consist of only double-stack cars, the SP common-user trains may also carry containers or trailers on conventional cars as required.

SP is also offering common-user double-stack service to and from Oakland via the Central Corridor over the Sierra Nevada.

Union Pacific. All double-stack trains on UP are dedicated trains, with the major customer being API. From Los Angeles, UP operates seven weekly API trains. Six terminate in Chicago and one goes on to South Kearny via Conrail. From Oakland, UP originates three weekly API trains to Chicago, which include pickups at Stockton and Sacramento. Connecting services, not full trains, are operated from Fresno. From Seattle, UP originates three weekly API trains, all to Chicago. Altogether there are thirteen API departures from West Coast ports on UP. Westbound, UP operates seven weekly multi-destination API trains originating on CNW at Chicago. These trains serve different mixes of API service points in the West. There are also three short-distance API movements, not full trains, westbound from Salt Lake City to Los Angeles on UP. Four weekly API trains move from Chicago via CNW and UP directly to Los Angeles. From Chicago via CNW, UP moves API domestic double-stacks to Dallas, Houston, San Antonio, and Laredo.

UP operates three other weekly double-stack trains. There is a weekly "K" Line train departing Long Beach to Chicago and New York (via CNW and CR). Another weekly "K" Line train operates from Tacoma to Chicago and returns westbound through Portland. The last dedicated UP stack train is operated for Maersk, departing Tacoma weekly for Chicago and return.

Although UP does not offer "common-user" double-stack service as such, UP does operate daily intermodal trains from Los Angeles, Oakland, and Seattle that can carry containers on conventional equipment. Moreover, API solicits traffic from other ocean carriers and third parties for its double-stack trains operating over UP.

Conrail. Conrail connects with the western railroads at Chicago and East St. Louis, and interchanges both entire double-stack trains and blocks of double-stack cars at both points. Solid trains are operated either on their own schedules or as sections of regular intermodal trains. Blocks of double-stack cars are added to Conrail's "TrailVan" intermodal trains.

Conrail handles API's traffic between eastern cities and the CNW interchange at Chicago. API schedules three weekly departures from South Kearny to Chicago. In Chicago, these trains connect with API's west coast services via UP/CNW. Eastbound, API schedules just one complete weekly train between Los Angeles and South Kearny, which travels over Conrail east of Chicago. Conrail, however, also handles API double-stack traffic on regular TrailVan trains between Chicago and South Kearny six days per week. Also from the UP/CNW connection at Chicago, Conrail handles weekly Chicago-New York trains for Maersk and "K" Line. Conrail receives weekly NYK and MOL double-stack trains from Soo Line at Chicago. These trains originate on SP in Southern California.

At East St. Louis, Conrail receives a block of MOL double-stack cars from SP (SSW). These cars are moved to Columbus, Ohio, to serve the nearby Honda plant at Marysville. The cars continue on to New York, where they are combined with the Chicago-New York MOL cars for the trip back west.

CSX. CSX handles the eastern rail operations of Sea-Land trains. The major movements are 3 weekly trains operating between Chicago (from SP and BN) and CSL's intermodal terminal at Little Ferry, New Jersey. CSX actually operates the trains between Chicago and Buffalo, where they are interchanged with the Delaware & Hudson. The D & H moves the trains to Binghamton, NY, where they are interchanged with the New York, Susquehana & Western for the last leg into Little Ferry. CSX also operates several other routes for Sea-Land: Chicago-Atlanta (2 per week); Chicago-Port

Covington (Baltimore); New Orleans-Charleston (as part of CSX's daily Gulfwind); and New Orleans-Jacksonville (with conventional interchange to FEC for Miami). Besides the Sea-Land traffic, CSX moves a portion of NYK's weekly east-west train between the SP interchange in East St. Louis and Cincinnati. CSX's Chicago-Baltimore service was originally begun by the Chessie System under an arrangement with the State of Maryland.

Norfolk Southern. NS moves API's traffic south of the Chicago-New York corridor. This includes Chicago-Atlanta service. NS also interchanges Atlanta-Los Angeles trains with SP at New Orleans, with a connection to Charlotte. For "K" Line and Maersk, Norfolk Southern presently operates two weekly round trips between Chicago and Welland, Ontario. For Hanjin, Norfolk Southern handles a weekly movement between BN at Chicago and NYSW at Buffalo (destination Secaucus, New Jersey). Maersk added service between Chicago and Montreal in early 1989, with NS to move the trains through Buffalo.

Regional Railroads. GTW moves API double-stack traffic between Chicago and Woodhaven, 18 miles from Detroit. Chicago and North Western provides UP and its customers with a vital connection between Fremont, Nebraska and Chicago. All of UP's dedicated trains for API, Maersk, and "K" Line use this route. Soo Line provides SP with a Kansas City-Chicago connection for those clients not using the BN connection. Iowa Interstate (IAIS) operates a domestic double-stack service for Interdom, Inc., for which Maytag Appliance provided the original start-up traffic. IAIS operates over a combination of its own trackage and trackage rights between Blue Island, Illinois and Council Bluffs, Iowa, providing daily service in the Chicago-Los Angeles corridor in conjunction with UP and CNW. Montana Rail Link handles some double-stack trains to or from connecting roads. The New York, Susquehana & Western (NYSW) was for several years the only regional railroad involved in double-stack traffic, carrying Sea-Land trains between Binghamton, New York and Little Ferry, New Jersey on a combination of NYSW's own trackage and trackage rights over Conrail. The Delaware-Hudson handles Sea-Land trains between Buffalo and Binghamton. Kansas City Southern handles a double-stack movement of imported coffee from New Orleans to the Midwest.

IC, and the remaining portions of the Guilford System (BM, MEC) do not now participate in double-stack movements. IC formerly provided a St. Louis-Chicago link for some SP double-stacks that have since switched to BN or Soo routes.

None of the other "new" regional railroads carries regular double-stack traffic. This is not surprising, since these regional railroads were formed from trackage sold by the Class I carriers, which is unlikely to include major intermodal corridors or hubs.

2. Backhaul Arrangements

Double-stack service depends, like all transportation services, on utilization. Utilization in turn depends on the ability to fill equipment with revenue-producing loads in both directions. Early double-stack services were based on international traffic, which has had a strong imbalance of imports over exports that placed a premium on the ability of carriers to attract westbound domestic or export backhaul freight. Although the increase in domestic container movements and the growth of exports has somewhat diminished the importance of backhaul freight, many of the arrangements made to solicit backhauls are still in place and will play a role in the further development of double-stack service wherever corridor flows are imbalanced -- and that means almost all corridors.

There are two basic approaches, the first typified by API's system. The underlying economies of American President's program are controlled in part by the terms of API's contract with Union Pacific. Although the actual terms are proprietary, the key features are:

- pass-through of equipment costs, giving API the incentive for high utilization;
- a round-trip rate, obligating API to pay for the movement of containers in both directions; and
- a relatively low "additive" rate for loads (rather than empties) in the light direction.

It is thus in the interest of both API and UP to fill the containers with backhaul freight. The "additive" rates give a fixed cost to API above which any backhaul revenue is net.

A second basic approach was taken by BN, ATSF, and SP. The ocean carriers from which these railroads were soliciting traffic did not buy domestic shippers' agents or make comparable investments in their ability to solicit westhound freight. BN, ATSF, and SP reached various agreements to "buy back" portions of the westbound capacity of the proposed trains, and to solicit the freight themselves.

This arrangement is implemented through a charge for moving empty containers, a charge for moving containers with ocean-carrier loads, and a different "management fee" for returning a container with a railroad-solicited load. The "management fee" is usually significantly less than the charge for moving an empty container, and the railroads typically agree to return the container to the West Coast within 30 days (which is often faster than the ocean carriers can get it back by themselves). Ocean carriers are thus encouraged to solicit exports through their own sales force, and to turn over the remaining empty containers to the railroad.

C. RAIL DOUBLE-STACK TECHNOLOGY

1. The Intermodal Fleet

The composition of the rail intermodal car fleet is changing rapidly. As shown in Table 6, there has been a massive increase in the double-stack fleet but a much smaller increase in the third-generation TOFC car fleet. The existing fleet of first and second generation TOFC and COFC cars is dwindling, and a much larger proportion of total intermodal capacity is devoted to containers, and specifically to double-stacks.

Double-Stack Cars. A dramatic change occurred in intermodal car design with the introduction of double-stack cars. As noted earlier, between 1977 and 1981 Southern Pacific and ACF developed and built the first double-stack cars. The SP/ACF cars use bulkheads to secure the containers.

Table 6

INTERMODAL FLEET

			Third Generation Cars		
	Total Spaces*	Conventional Cars	Trailer Cars	Double-Stacks	Road-Railers
1983	110,000	109,000	200	400	300
1984	112,000	109,000	700	2,000	300
1985	119,000	109,000	2,900	7,000	300
1986	118,000	102,000	3,100	13,000	300
1987	116,000	93,000	4,800	18,000	1,400
1988	118,000	88,000	5,800	24,000	2,300
1989	120,000	79,000	9,000	30,000	2,300

* Units are trailer or container spaces or slots.

Source : Greenbrier Intermodal

In 1984, American President Lines placed its first double-stack cars in service. They were built by Thrall and designed by Budd. A major feature of these cars was the use of interbox connectors (IBCs) to lock the containers in position. The original cars had 40-foot wells. Starting in 1985, Thrall produced new well lengths to accommodate 48-foot containers, although they could already be carried on the top layer. The provision of multiple attachment points on domestic containers of 48-feet and 53-feet allows them to be stacked on top of 40-foot and 45-foot containers.

"Twin-Stack" bulkhead cars was introduced by FMC in 1984, and subsequently built and marketed by Gunderson. No bulkhead cars have been produced since 1987. The need to accommodate larger containers and the desire to maximize weight capacity have led Gunderson to re-design recent offerings as IBC cars, eliminating the bulkheads. These new designs are marketed as "Maxi-Stack" cars.

Trinity's double-stack cars are derived from a Youngstown "Backpacker" prototype, using an IBC design. About 300 Trinity cars had been delivered to Trailer Train and BN.

Table 7 compares the principal features of six different double-stack "models" built by Gunderson, Thrall, and Trinity, and the comparable specifications of the Trailer Train "spine car" (as built by Trinity). Several points are immediately apparent:

- o bulkhead cars (Gunderson Twin-Stacks) have a higher tare weight and a lower net capacity than IBC cars;
- o total length grows with the ability to handle larger containers, up to a point (the ability to place 53-ft. containers on the upper level of 48-foot IBC wells entails no length penalty); and
- o all of the current double-stack designs have substantial tare weight advantages over the spine car.

The specifications also show that the newest double-stack cars from the three active builders are all very much alike. The Gunderson Maxi-Stack

Table 7

DOUBLE-STACK AND SPINE CAR COMPARISONS

	Type	Bottom/Top Container Lengths	Tare Pounds Per Platform	Net Pounds Per Platform	Overall Length
LO-PAC 2000	IBC	40/14	30,050	100,000	266-1
LO-PAC II	IBC	40/48	37,000	122,000	267-5
Twin Stack	Bulkhead	40/45	34,000	100,000	265-1
Maxi Stack	IBC	40/48	35,400	124,000	265-1
Maxi StackII	IBC	48/53	36,800	122,000	289-8
Backpacker-48	IBC	40/48	32,400	102,500	267-2
Spine Car	-	48/--	26,120	67,200	251-7

Source: Trailer Train and Manufacturers.

II, the Thrall LoPac II 40/48, and the Trinity Backpaker-48, are all about 290 feet long, weight 36,000 - 38,000 lbs. per platform, and can accommodate 48-53 ft. containers.

Table 8 provides weight comparisons between several car types. The double-stack cars offer significant advantages in net/tare ratio and in net tons per coupled length. Simply put, double-stack cars are a more efficient intermodal line haul vehicle.

2. Carless Technologies

Carless technologies seek to maximize rail linehaul efficiency by eliminating the railcar itself. This approach yields additional benefits in the ease of loading and unloading, and in minimizing the need for facility investment.

The RoadRailer, in its various forms, is the most common carless technology and the only one that has seen commercial application. Indeed, "RoadRailer" is sometimes used as a generic term for carless technologies. The primary advantages of RoadRailers are the reductions in tare weight compared to TOFC technology, the elimination of a separate chassis, the reduction in investment for railcars (although the Mark V requires an investment in bogies), and greatly reduced facility cost. RoadRailers themselves are expensive, however, relative to trailers: roughly $40,000 rather than $5,000. (Although the cost difference has been reduced with RoadRailer's new "SST" model.) This greater capital expense creates problems with railroad control over equipment that leaves the property, and utilization becomes critical. RoadRailers are also at a tare weight disadvantage relative to trailers, although the Mark V version narrows the gap. As Table 8 indicates carless technologies offer clear net-to-true advantages over conventional TTX types, and a mixed comparison with double-stacks.

The differences in terminal requirements can be dramatic. Double-stacks require mechanical lift equipment and paved terminals capable of handling long trains. Carless technologies require only a gravel surface and a yard

Table 8

WEIGHT CAPACITY COMPARISONS

Car Type	Net Weight Capacity (lbs.)	Total Tare Weight (lbs.)	Coupled Length (ft.)	Net/ Tare	Net Lbs. Per Foot
Standard TOFC, 2 45-Foot Vans	104,000	93,600	93-8	1.11	1,110
Front Runner 48-Foot Van	50,000	40,000	53-10	1.25	929
Impack 5 45-Foot Vans	260,000	190,000	263-2	1.37	988
Standard COFC	116,000	83,800	94-8	1.38	1,225
Spine Car 5 48-Foot Containers	295,500	195,000	251-8	1.52	1,174
Double-Stack IBC 5 45-Foot Containers 5 48-Foot Containers	526,800	267,250	289-8	1.97	1,819
Boxcar 70-Ton, 50'6"	154,000	66,000	55-7	2.33	2,775
RoadRailer Mark V	48,800	16,200	48-0	2.01	1,017

Source: Manufacturers and Industry Publications tractor. This difference may give the carless technologies an advantage in low-volume corridors.

III. CRITERIA FOR DOUBLE-STACK OPERATIONS

A. DOUBLE-STACK SERVICE CRITERIA

One of the central tasks in this study is the identification of potential corridors for domestic double-stack service, with and without international traffic. The double-stack train will travel hub-to-hub, and railroad involvement will extend gate-to-gate, but double-stack service must extend door-to-door, and be judged by door-to-door standards. To that end, criteria were established for each of the major features of double-stack service (cost being considered separately):

- o Dedicated vs. mixed trains;
- o Train length;
- o Service frequency;
- o Transit time;
- o Length of haul; and
- o Traffic volume;

These criteria are not intended to describe every conceivable double-stack service, nor to imply that every double-stack service that meets them will be successful. Rather, they are intended to describe service features associated with likely corridors for near-term domestic double-stack services, and to provide insight into the competitive nexus between double-stack rail services and truck services.

1. Volume, Train Length, and Service Frequency

Operating Methods. There are three possible operating methods for implementing domestic rail container service:

a) as double-stack train service in high-volume corridors;
b) as part of existing intermodal train service, using double-stack cars;

c) as part of existing intermodal train service using standard intermodal cars or spine cars (i.e., as COFC service).

In recent years, double-stack operations have been increasingly integrated with other rail intermodal operations, and a "double-stack train", except for dedicated trains tied to ship arrivals, may include other car types. Where sufficient volume is not available to run full double-stack trains, blocks of double-stack cars are added to existing intermodal trains.

Dedicated Double-stack Trains vs. Mixed Double-stack Service. The first double-stack services were provided only on dedicated double-stack unit trains. This image of double-stack service has been reinforced by press releases announcing new trains and services, and by publicity photographs showing solid trains of identical double-stack cars and containers. This image is inaccurate. Beginning with the introduction of common-user trains and other operations catering to customers with less-than-trainload volumes, double-stack cars were mixed with other intermodal cars or even with non-intermodal freight cars. Railroads continue to mix intermodal car types to even out traffic peaks and valleys.

Dedicated double-stack trains are not necessary for double-stack service. A double-stack train is easily defined: a train consisting solely of double-stack cars and locomotives, with or without a caboose. Double-stack service is equally easy to define: "regular movement of double-stack cars," or "the opportunity for rail customers to ship containers on double-stack cars." Neither definition of double-stack service requires the existence of all-double-stack trains. A distinction must be made, however, between double-stack services scheduled for ocean carrier traffic (which may carry some domestic traffic) and double-stack services intended to compete in the long term for domestic rail and truck traffic. Several existing intermodal corridors have only 1-2 double-stack trains per week, each scheduled to complement ocean carrier operations. These trains may indeed attract some opportunistic domestic traffic, but they will not be long-term competitors for motor carriers.

Single-Line vs. Interline Service. Single-line service (line-haul movements over one railroad, or one commonly owned railroad system) is preferred for truck-competitive domestic double-stack service. Single-line service places responsibility for service quality squarely on one organization. Single-line service also eliminates any service delay, operating cost, or administrative burden from interchanging cars between railroads. Most double-stack services are single-line services at present. Interline intermodal services are of three basic types: run-through services, interchanges, and rubber-tired transfers. They are acceptable for truck-competitive double-stack service to the degree that they resemble single-line service.

In run-through service, entire trains are exchanged between railroads. The best run-through services do not differ substantially from crew changes taking place in single-line service. Well-managed run-through trains should be fully competitive with single-line service. Run-through service should not substantially increase operating costs. There may be some disadvantage in the area of claims responsibility, since each railroad would tend to blame the other for damage or delay.

Routine interchanges of individual cars or groups of cars between railroads are too slow and unreliable for truck-competitive intermodal service. Delays, additional handling, and fragmented responsibility all adversely affect service quality. Of particular concern is the all-too-common case where minor delays on one railroad become major delays when cars fail to arrive in time for connecting trains. Although it is technically possible to have a reliable, expeditious, low-cost interchange, it is rarely achieved within the standards set for truck-competitive double-stack service.

In rubber-tired transfers, the trailer is unloaded, drayed across to a second railroad terminal, and re-loaded to continue its trip. This is a costly means of transfer, but it is often used by third-party shippers to avoid more lengthy delays for routine interchange of TOFC cars. Rubber-tired transfer is too costly, too unreliable, and fragments responsibility too badly to be considered for truck-competitive domestic container services.

Train Lengths. Maximum train length is primarily an operating decision (although there are economic and service tradeoffs, which will be addressed elsewhere). Length *per se* is a problem when it approaches, let alone exceeds, the length of available sidings which are needed to allow double-stacks to meet or pass other trains on the main line.

The first double-stack trains were of fixed length, usually 20 five-platform cars, and were operated on weekly schedules. The shortest regularly scheduled double-stack trains consist of 15 five-platform cars, carrying a total of 150 FEU. The longest regularly scheduled double-stack trains consist of 28 five-platform cars, carrying a total of 280 FEU.

The first production double-stack cars were approximately 265 feet long. A 15-car train therefore would be roughly 4000 feet long, without locomotives. This length is well within the siding length common on heavily used mainlines, and would rarely require new trackwork. In comparison, a 75-car train of conventional COFC cars (which are 93 feet long over couplers), which would also carry 150 FEU, would be nearly 7000 feet long. Second-generation double-stack cars are roughly 290 feet long, and high-capacity third-generation cars are 305 feet long. These lengths yield 15-car trains of 4350 feet and 4575 feet, respectively, without locomotives. These 15-car trains would still fit in most existing mainline sidings, which typically range up to 6000 feet.

With 265-foot cars, a 28-car train is 7400 feet long, exceeding the siding lengths commonly found on high-density single-track mainlines. With 290-foot and 305-foot cars, 28-car trains would exceed 8100 feet and 8500 feet, respectively, without locomotives. These lengths would require even greater efforts to extend sidings on single-track mainlines. There is a discernible trend toward shorter double-stack trains to provide faster, more frequent service, and to obtain more operating flexibility. Moreover, many of the larger trains leaving major ports are split at some intermediate point into two shorter trains to serve two different inland destinations.

For all of the above reasons, this study employs a 15-car, 150-FEU minimum, and a 28-car, 280-FEU maximum train length. The annual container volume required for such trains depends on the service frequency. Table 9 gives annual one-way container (FEU) volumes corresponding to various service frequencies for 15-car and 28-car trains.

Table 9

ONE-WAY
ANNUAL CONTAINER VOLUMES FOR
DOUBLE-STACK SERVICES
(FEU per year)

Service Frequency	Minimum 15-car trains	Maximum 28-car trains
Weekly	7,800	14,560
3 days/week	23,400	43,680
5 days/week	39,000	72,800
6 days/week	46,800	87,360
7 days/week	54,600	101,920
11 trains/week	85,800	160,160
2 trains/day	109,200	203,840

A five-day-per-week schedule would allow double-stack service to compete effectively for much, but not all, common-carrier truckload freight. Most industrial customers, and the third parties that serve them, expect to ship and receive freight five days per week, and they are unlikely to give regular business to a double-stack service that offered less frequent departures. Some current and potential intermodal customers require service six days per week. Such customers include major sources of intermodal traffic: United Parcel Service, the U.S. Postal Service, and LTL motor carriers, for example. Six days per week should be considered the minimum service frequency for a truck-competitive domestic double-stack service. The minimum annual volume to establish a truck-competitive double-stack service would then be 46,800 units: the equivalent of a 15-car train, six days per week.

Significant reductions in hub dwell time, overall transit time, and customer service can be achieved by providing two or more daily trains. Such improvements are sometimes referred to as "service economies of scale": overall service improves because the average wait between container arrival at the origin hub and train departure (and vice versa at destination) is reduced. In addition, service may be provided to an intermediate hub, which daily trains do not serve. As Table 9 shows, however, the step from daily service to twice-daily service is a long one.

Once double-stack service is established in a corridor, it should be possible to offer double-stack service to and from intermediate points with lower volumes, as long as the haul length meets other criteria. Such points would most likely be served by picking up and setting out cars, rather than by loading or unloading containers while cars remained in the train. A minimum feasible volume for service to an intermediate point would therefore be one car, and would have to be provided at least five days per week to compete for truck traffic, if not for UPS, Postal Service, and LTL traffic. The minimum annual volume for service to intermediate points on an established or potential double-stack corridor thus would be 2,600 containers, the volume generated by a single five-platform car per day, five days per week.

2. International Versus Domestic Trains

The service criteria contemplate six-day-per-week service with trains of at least 15 double-stack cars. A review of the likely pattern of international and domestic traffic indicates that the available mixture will lead railroads and their major customers to run mixed international and domestic trains most of the time. There will be few operational distinctions between international and domestic trains, and few trains will be purely one or the other. The only trains that will remain purely international are eastbound trains from the West Coast, and westbound trains from the East Coast, that are scheduled to receive inbound containers from specific vessel calls. Other trains from the coasts, even those run for the domestic subsidiaries of ocean carriers, will carry a mix of international and domestic containers that fluctuates according to the daily traffic situation.

Both domestic and international movements follow what has been termed a "transcontinental calendar". Wherever possible, departures are scheduled to provide weekday arrivals at destination. Vessel calls in Southern California, for example, are now clustered between Friday and Monday in order to position intermodal containers for mid-week delivery in Midwest markets. Eastbound international movements will therefore peak between Friday afternoon and Monday morning. Domestic shippers, however, avoid the weekends: eastbound domestic shipments generally begin Monday morning and end Friday afternoon. The top half of Figure 12 illustrates this weekly eastbound traffic pattern for Southern California.

Westbound traffic patterns are different. International export and empty containers begin arriving at the rail terminal late Wednesday in preparation for Friday vessel calls, and to free up double-stack cars for priority eastbound imports. Westbound exports and empty container movements taper off Sunday and Monday, as vessel calls decline. Domestic arrivals increase on Sunday for local delivery on Monday, and taper off later in the week: Friday afternoon and evening arrivals would not be delivered until Monday, and neither the railroads nor the shippers want to store loaded trailers. The westbound pattern is shown in the bottom half of Figure 12.

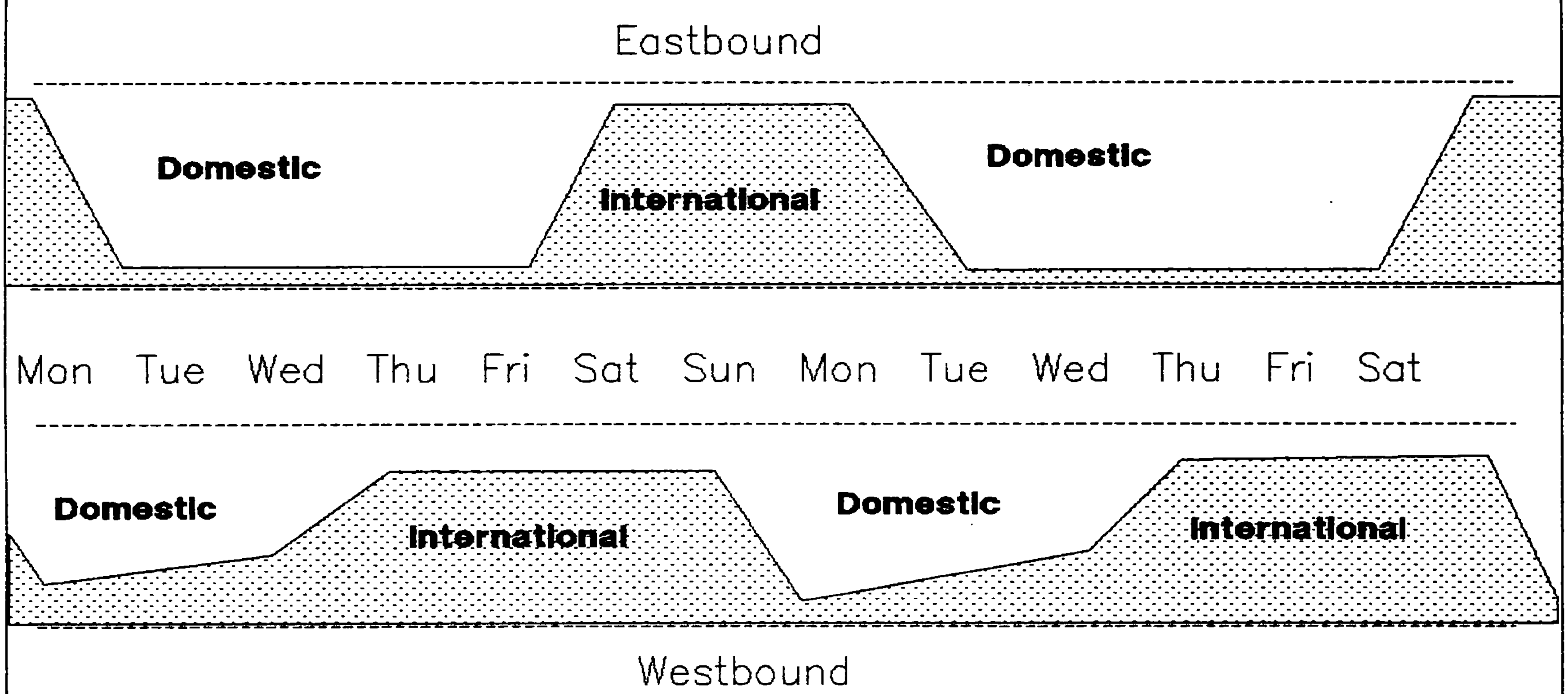


Figure 12

Sample Southern California

Double-Stack Traffic Patterns

A comparison of the top and bottom of Figure 12 suggests that it would be inefficient, or even futile, to attempt to segregate international and domestic linehauls completely in Southern California. To be sure, there are multiple trains on most days, but those trains are divided between three railroads. Achieving high utilization and low cost dictates that arriving westbound cars be unloaded and reloaded with eastbound containers as quickly as possible.

International and domestic containers generally will not be segregated on separate trains. It appears much more likely that train operations will be adapted to minimize transit times and maximize equipment utilization.

3. Start-up Threshold

Railroads are generally willing to start services with less than the volume required for long-term viability if there is sufficient immediate business to survive until volume grows, and if the railroad is confident that business will grow to the long-term minimum within an acceptable length of time. There are no concise criteria for such a decision, because the decision to begin a service will depend on subjective assessments of:

- the potential market and potential profitability;
- the availability of capital to start and support the service until it reaches profitability;
- the actions and likely reactions of competitors; and
- the strategic plans of railroad executives.

With no means to derive an analytical criterion, this study uses a somewhat arbitrary threshold start-up volume figure of 60 percent. It was judged unlikely that railroads would routinely begin operations with less than half of the long-term minimum volume, yet setting a higher threshold might unduly restrict the analysis of potential network developments and impacts.

For a new corridor, 60 percent of the 46,800-unit annual minimum volume is 28,080 units. For intermediate points, 60 percent of the 2,600-unit annual minimum volume is 1,560 units.

4. Double-Stack Stem and Dwell Times

To compete with door-to-door truckload service, a double-stack service must complete five segments in the same time frame:

- stem time from shipper to origin hub;
- dwell time at origin hub;
- hub-to-hub rail line-haul time;
- dwell time at destination hub; and
- stem time from destination hub to consignee.

Stem time. No hard data exist on the distribution of origin stem (drayage) times. Some sources indicate that major intermodal hubs can draw traffic from 250 or more miles away, for which the one-way stem time would be 4-6 hours. Such exceptionally long drayages would be justified only by the longest line-hauls, and would have to take place in the direction of travel: "with the grain". One measure of the minimum stem time allowance for a truck-competitive domestic double-stack service is the time required to serve the ICC-defined "commercial zone" surrounding major metropolitan cities. Most major commercial zones are 30 to 60 miles across, and rail facilities tend to be centrally located. For purposes of estimating a minimum origin stem time, this study assumes one hour to cross 30 miles of a commercial zone in moderate traffic and to complete check-in procedures at the rail facility gate.

Dwell time. The average dwell time at origin can be broken down into two components:

- the average time between container or trailer arrival at the rail hub and train cutoff time; and

- the scheduled time between cutoff time and actual departure.

Railroads announce cutoff times for specific train departures to insure that enough time is consistently available to load the train. The shortest dwell times can be achieved with dedicated double-stack trains for which loading plans are provided, and for which containers arrive in a steady stream during the day. Railroad sources report that under the best conditions containers for such trains can be accepted up to one-half hour before scheduled departure. The longest times between cutoff and departure are associated with common-user double-stack trains, which handle an unknown mix of containers arriving randomly from a mix of customers who do not provide advance loading plans. Railroads reportedly allow as much as six hours between cutoff and departure for the most troublesome trains.

A domestic double-stack system cannot expect that domestic containers will be organized as well as international containers from a single ship. On the other hand, the potential performance of double-stack services should not be limited to the lower end of existing services. This study assumes that facility improvements, better communications and documentation from the shipper, and particularly increased use of Electronic Data Interchange (EDI) and Automatic Equipment Identification (AEI) will allow railroads to accept containers up to <u>two hours</u> before departure. This standard is currently exceeded by some dedicated trains, which have one-hour cutoffs.

<u>Origin stem and dwell time</u>. The <u>minimum</u> typical stem and dwell time of three hours would correspond to a shipper who finishes loading at 4:00 p.m. for a 5:00 p.m. cutoff time:

Stem time:	1 hour	(4:00 p.m.-5:00 p.m.)
Dwell time:	0 hours	(5:00 p.m. cutoff)
Loading time:	2 hours	(5:00 p.m. cutoff to 7:00 p.m. departure)
	3 hours	

Therefore, this study uses a <u>3-hour minimum</u> for stem-and-dwell time at origin, corresponding to a high standard for time-sensitive traffic.

<u>Destination stem and dwell time</u>. The dwell time at destination depends on the rail customer. The railroad notifies the customer when the container or trailer will be available, and the customer chooses how and when to have it picked up. An arriving double-stack train can be unloaded immediately upon arrival, a process that takes up to 6 hours for a 20-car train, less if multiple lift machines are used. The typical container would therefore be unloaded and available for pickup three hours after train arrival.

In trying to assess potential competition with motor carriers, it is the time-sensitive customers that are relevant. Industry sources indicate that time-sensitive customers notify their draymen of incoming loads well before train arrival. Railroads "cherry pick" the train to meet the demands of such customers, either by using multiple lift machines on the train or by using sideloaders, which are more mobile than gantries, to unload selected units. The drayman (and his customer) incurs the cost of an access trip to the rail yard, but this trip does not add to total transit time because it overlaps the train arrival and unloading time. This study uses a two-hour unloading time to reflect priority treatment of time-sensitive loads without assuming the highest priority for every unit. (The average would be three hours for a train that took six hours to unload.) The potential competitive destination stem-and-dwell time would therefore be three hours, as it is at origin:

Unloading time:	2 hours	(0-6 hours range)
Stem time:	1 hour	(half commercial zone, 30 miles)
	3 hours	

The total rail stem-and-dwell time used in this study is therefore six hours, three hours each at origin and destination. This is a high standard, met at present by only a few highly efficient operations and demanded by only the most time-sensitive intermodal customers. Nonetheless, it appears to be an achievable standard and reflects the potential performance of rail double-stack service in competition with motor carriers.

5. Truckload and Double-Stack Transit Times

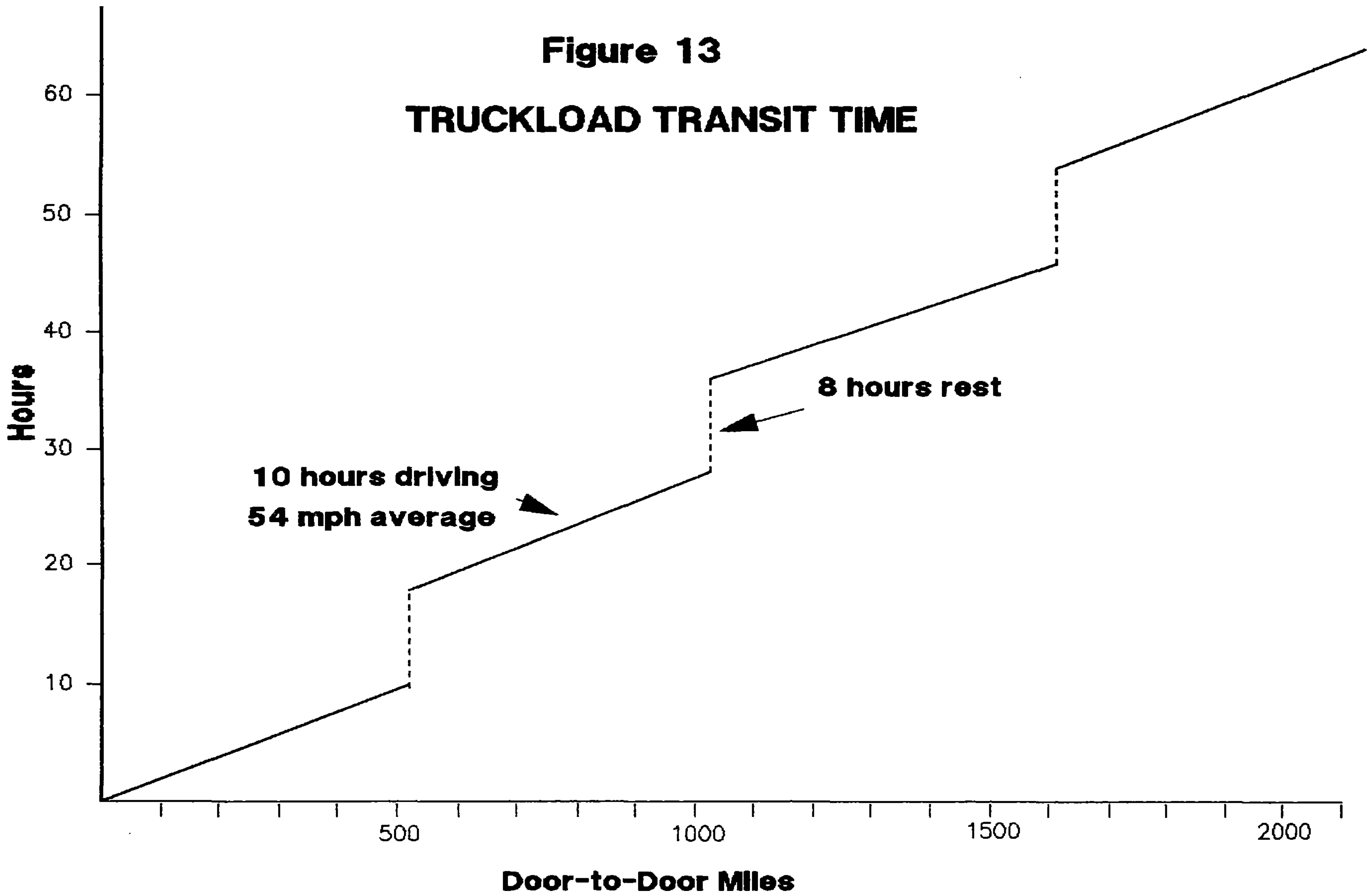
The principal long-term competitor for rail double-stack service is the single-driver truckload common carrier. It is generally conceded that rail intermodal service cannot compete with truckload carriers who use two drivers (or relay drivers) to provide the fastest possible motor carrier service. It is also conceded that no intermodal technology available can compete with multiple-stop truckload carriers. The range of potential competition between rail intermodal service and LTL motor carrier service is largely limited to occasions where intermodal service can replace the "truckload" haul between LTL terminals. This analysis therefore focuses exclusively on single-driver truckload competition.

One critical feature of single-driver operations is the need for periodic rest. Under Federal regulations, drivers are permitted to drive a maximum of 10 hours before resting at least eight hours. Industry sources indicate a typical truckload driver travels 540 miles in those 10 hours. The average of 54 miles per hour includes short rest stops and slower travel, as well as freeway travel in the 55-65 m.p.h. range. Drivers can actually remain on duty 15 hours, if the remaining time is spent loading or unloading. Although in practice drivers will often drive 12 hours or more to complete a trip in a single stint, this study is predicated on lawful operation of all modes over the long run. The 10 hours on/8 hours off driving cycle yields the stepped time-distance function shown in Figure 13. Actual trip patterns would not be this regular, since drivers adjust to meet delivery times in distant cities, but Figure 13 gives a useful abstraction of truckload movements.

Over the linehaul, railroads move at <u>slower average speeds</u> than trucks. Intermodal trains with adequate power are capable of high speeds where grades are minimal and track conditions permit. Yet even in the western states, mountain ranges, urban areas, and other rail traffic slow and stop even high-priority trains. Train crews must be changed, locomotives serviced, and cars inspected. Interchanges, even run-throughs, slow intermodal trains further. The fastest long-distance intermodal schedules in the West call for average speeds of approximately 40 m.p.h. Trains, however, need not stop for rest. By changing crews, the railroad keeps a high-priority train moving while the trucker rests. As a result, the rail intermodal movement can be portrayed graphically as a straight line. Figure 14 shows a straight line corresponding to an average speed of 40 m.p.h. The line originates at 6 hours and 0 miles, indicating intermodal's 6-hour stem and dwell disadvantage. The 40 m.p.h. average is a high, but achievable standard for most major rail corridors.

Figure 13

TRUCKLOAD TRANSIT TIME



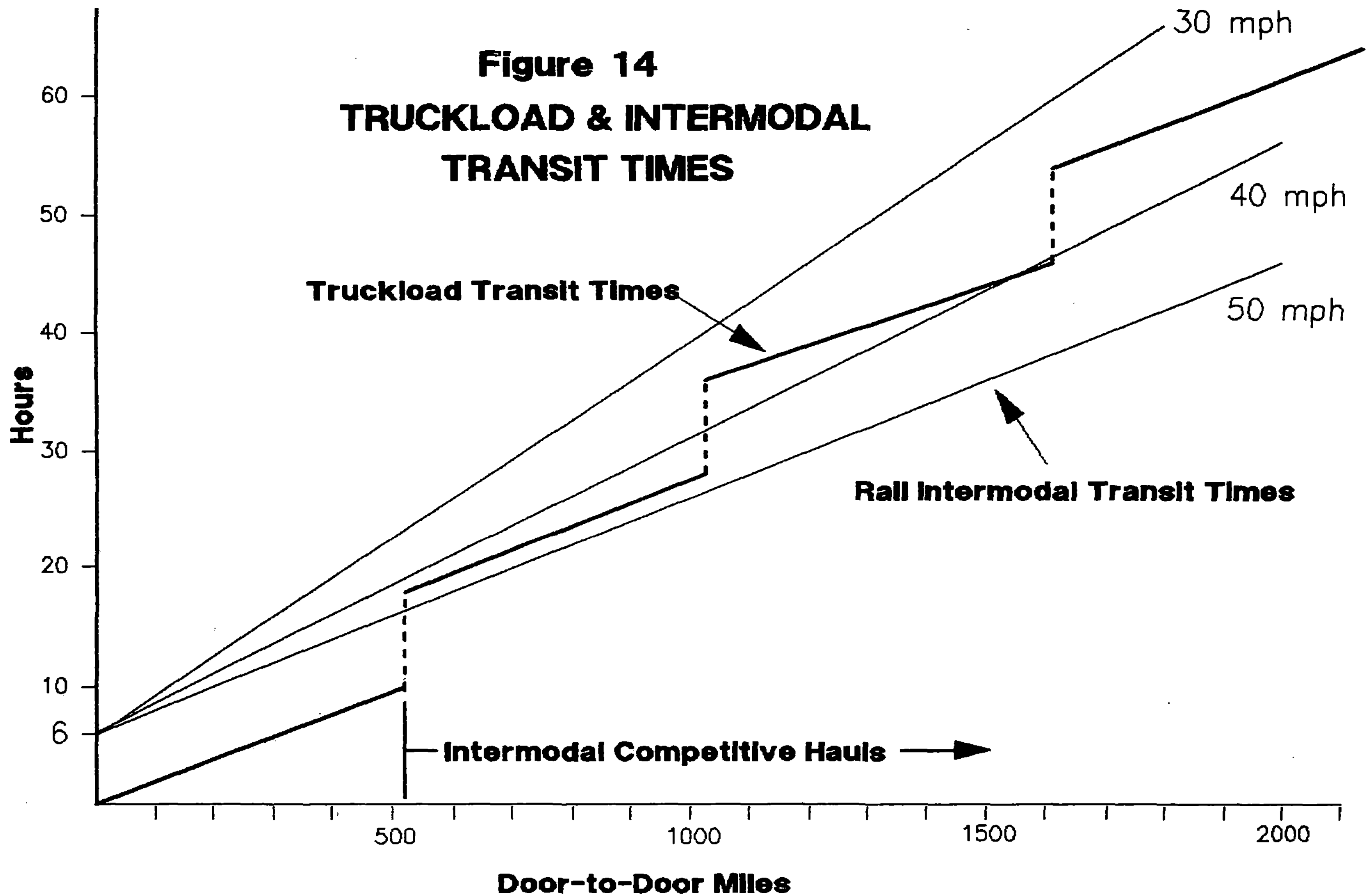


Figure 14
TRUCKLOAD & INTERMODAL
TRANSIT TIMES
30 mph
40 mph
50 mph
Truckload Transit Times
Rail Intermodal Transit Times
Intermodal Competitive Hauls
Hours
60
50
40
30
20
10
6
500
1000
1500
2000
Door-to-Door Miles

6. Length of Haul

At an average of 40 m.p.h., rail intermodal service could overcome the initial six-hour disadvantage and be reasonably competitive (delivering the same morning or afternoon) with a single-driver truckload service at any distance beyond one day's drive, 540 miles. A 700-mile door-to-door trip, for example, would take the motor carrier roughly 21 hours (10 hours driving, 8 hours rest, 3 hours driving). The same door-to-door trip would require about 22 hours by rail (6 hours stem-and-dwell, 16 hours at 40 m.p.h.).

Intermodal service becomes more competitive as the length of haul increases. Figure 14 shows that intermodal has a small disadvantage in the 540-1080 mile range, is roughly equal to truck in the 1000-1620 mile range, and has a significant transit time advantage for trips of over 1620 miles. It also shows clearly why it is difficult to operate competitive intermodal services for door-to-door trips of 500 miles and under. For all practical purposes, a single-driver truck does not stop between origin and destination for such hauls, and the railroad has little opportunity to make up the stem-and-dwell handicap.

Door-to-door trips between 540 and 1080 miles are the intermodal battleground. Under the best conditions likely to be encountered, intermodal operations can compete on service and transit time with single-driver truckload operations at the shortest distances in this range. Under less-than-ideal conditions -- circuitry, slow terminals, poor track, or lack of management commitment -- intermodal services will be forced out of the shorter hauls in this range. Intermodal market share is almost negligible in door-to-door hauls of less than 500 miles.

Many of the recently inaugurated premium conventional intermodal services serve corridors in this distance range, including examples of Burlington Northern Expediters, Norfolk Southern Triple Crown RoadRailer services, Santa Fe Quality Service Network trains, and Southern Pacific Track Stars. These trains, many of which are operated by reduced crews, are explicitly designed to compete with trucks.

Figure 15 shows the effect of drayage direction. Drayage "with the grain" reduces the intermodal disadvantage to four hours (lowering the intermodal line on the graph). The result is increased competitiveness, but only for distances of over 540 miles. Drayage "against the grain" reduces intermodal's competitiveness most markedly for door-to-door trips in the 540-1080 mile range; longer trips are less affected. It is clear, however, that intermodal operations in the critical 540-1080 mile range could not support drays of more than an hour or so against the direction of line-haul travel.

Considering the shaded area in Figure 15 instead of the single 40-m.p.h. line gives consistent results: rail intermodal operations can be competitive in the 540-1080 mile range while allowing drayage across typical commercial zones in all directions. The 540-mile door-to-door haul thus appears to be the shortest market in which conventional or double-stack operations can offer transit times competitive with single-driver truckload operations.

B. COST CRITERIA FOR DOUBLE-STACK SERVICES

1. Overview

The second major factor in the potential for double-stack container services is cost, both operating cost and total cost. The primary emphasis in this study is on operating cost (including appropriate capital costs), since operating cost reflects the potential performance of competing technologies. Total cost depends on organizational policies, marketing practices, overhead costs, taxes, and other factors independent of double-stack technology.

In keeping with the focus of this study on the potential for double-stack container service, this analysis seeks to determine the lowest cost at which regular double-stack service could be expected to operate. This approach requires that each major factor in double-stack operation be examined to establish reasonable minimum costs consistent with a high quality of service. The most complex factor is the rail line haul, for which this study uses computerized cost simulations. The analyses of other

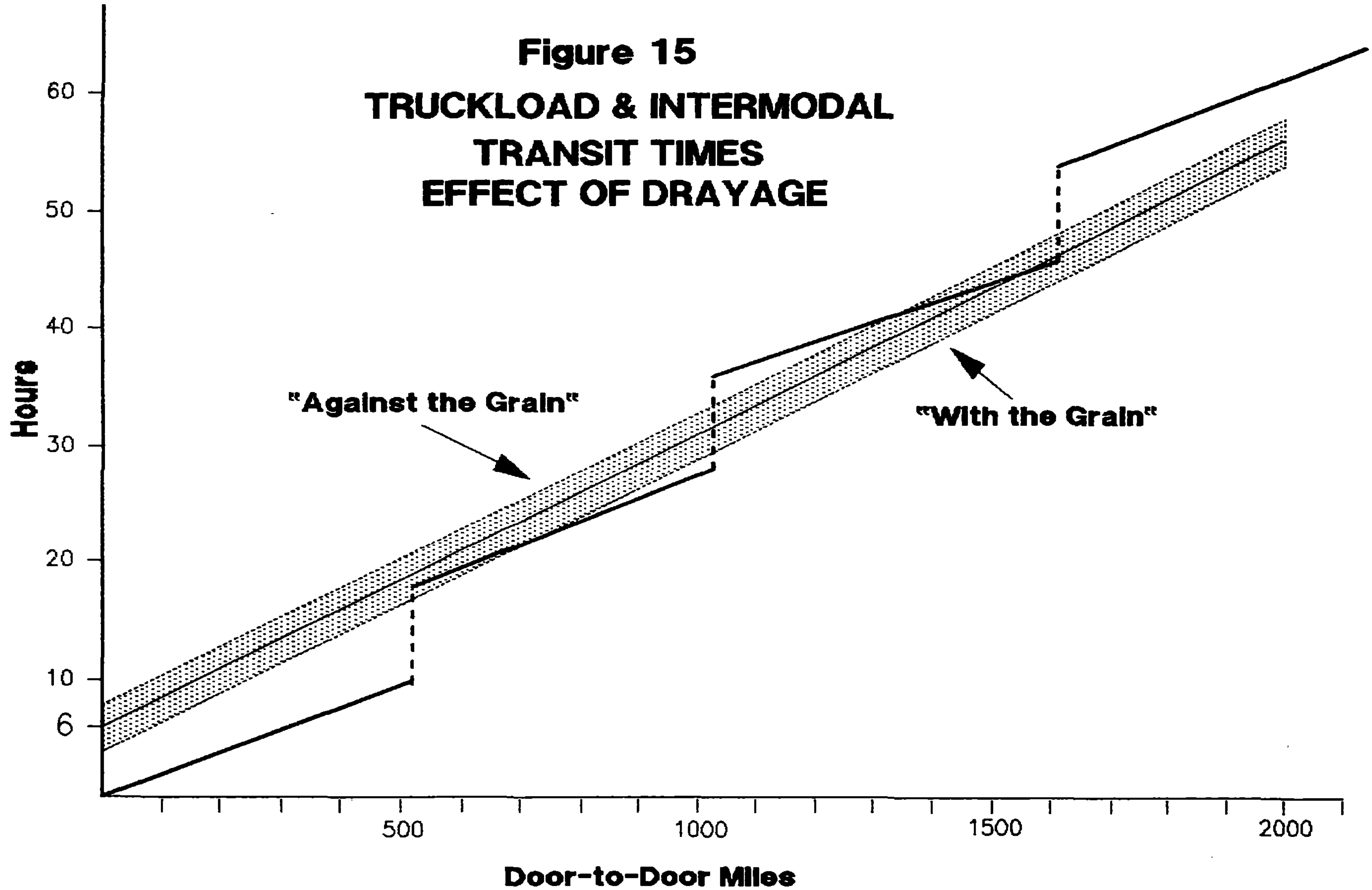


Figure 15
TRUCKLOAD & INTERMODAL
TRANSIT TIMES
EFFECT OF DRAYAGE
"Against the Grain"
"With the Grain"
Hours
60
50
40
30
20
10
6
500
1000
1500
2000
Door-to-Door Miles

factors draw on a variety of industry sources for critical assumptions and cost estimates.

2. Truckload Operating Costs

For the purposes of this study, the most critical cost comparison is between double-stack and truck operating costs. Assuming double-stack and truck rates bear the same relationship to the corresponding operating costs, truck costs constitute a competitive upper bound on double-stack costs. Truckload operating costs (exclusive of licenses, taxes, general and administrative costs, or other overhead) are roughly $.71 per mile, estimated by TRAM as follows:

Equipment: $40,000 annual ownership and maintenance cost and 129,000 average annual miles yield $.31 per mile.

Fuel: Mid-1988 and mid-1987 costs of approximately $1.05 per gallon, and average consumption of 5.22 mpg (ATA) yield $.20 per mile.

Labor: Average wages and benefits of $11.00 per hour and average speed of 55 miles per hour yield $.20 per mile (confirmed by 19,500 NMTDB interviews in 1987).

The most efficient firms are the so-called "advanced truckload firms" ((ATLFs). These firms use sophisticated computer information systems and communication to maximize service quality, responsiveness, and utilization. ATLFs reportedly approach $.89 per laden mile, which suggests a utilization factor of about 80 percent, typical of the industry. These costs do not include any allowance for overhead (dispatching, billing, management, etc.) or profit, and thus do not correspond to average system costs, rates, or revenues.

Double-stack rates must be discounted from truck rates. Customers are not willing to pay as much for intermodal service as for truck service. For the immediate future, moreover, double-stack service (in all its many aspects) will not be as good as the best truck service. The required discount for TOFC service has been about 15 percent from truck rates. The required discount for double-stacks might eventually be reduced, as double-stack service distinguishes itself from TOFC service and gains a more truck-competitive reputation with shippers. Yet as recently as mid-1989, a private shipper survey revealed that customers not only expect double-stack service to offer a discount from truck rates, but a discount from TOFC rates as well. Many customers apparently feel "the top container rides free". This perception was fostered by early publicity on double-stacks, which emphasized its cost advantages over TOFC, and by aggressive pricing of domestic backhauls by ocean carriers. A 15 percent discount may thus be conservative for the near future.

3. Rail Equipment Costs

Double-Stack Cars. Trailer Train is the major source of double-stack (DTTX) cars. Moreover, railroad and supplier contacts agreed that Trailer Train's rates serve as a benchmark for the industry. The Trailer Train rate generally includes a per diem charge and a mileage charge. These are full-service rates, including both time-based and mileage-based maintenance. The most recent Trailer Train double-stack purchases are "heavy lift" cars, with 125-ton trucks, capable of handling 20-foot to 48-foot containers in all wells. The current rate for these cars is $69.84 per day and $0.065 per mile, per car (10 wells). This rate equates to a cost of $6.98 per day and $0.0065 per mile for each platform, well, or 40-foot container unit.

The table below summarizes these car costs:

Rail Car Costs
$/Unit

Type	Per Day	Per Mile	Total Mileage Equivalent*
Double-Stack (DTTX)	$ 6.98	$ .0065	$ .0138
Conventional (TTWX)	$ 5.16	$. 015	$ .0204
Impack (UTTX)	$ 8.16	$ .015	$ .0235

*At 40 mph, 24 hours per day.

Source: Trailer Train

Mileage rates reflect differences in maintenance expense: both conventional and Impack cars have trailer hitches, which are expensive to maintain. The differences in mileage costs amount to more on the long hauls typical of intermodal movements. On a 2,000 mile haul, the difference between \$0.0065 per mile and \$0.015 per mile comes to \$17.00 per unit. The table also shows a total mileage equivalent, including per diem at 40 mph for a 24-hour day. The per diem charges for Trailer Train cars apply to time spent in terminals as well as time spent on the road. If a double-stack car spends 12 hours in the terminal at each end of the line-haul, it would accumulate 12 hours of terminal time for each one-way trip. For double-stack cars, this per diem implies a fixed cost of \$3.49 per well in addition to the variable line-haul costs. For conventional and Impack cars, the fixed terminal cost is \$2.68 and \$4.08 per unit, respectively.

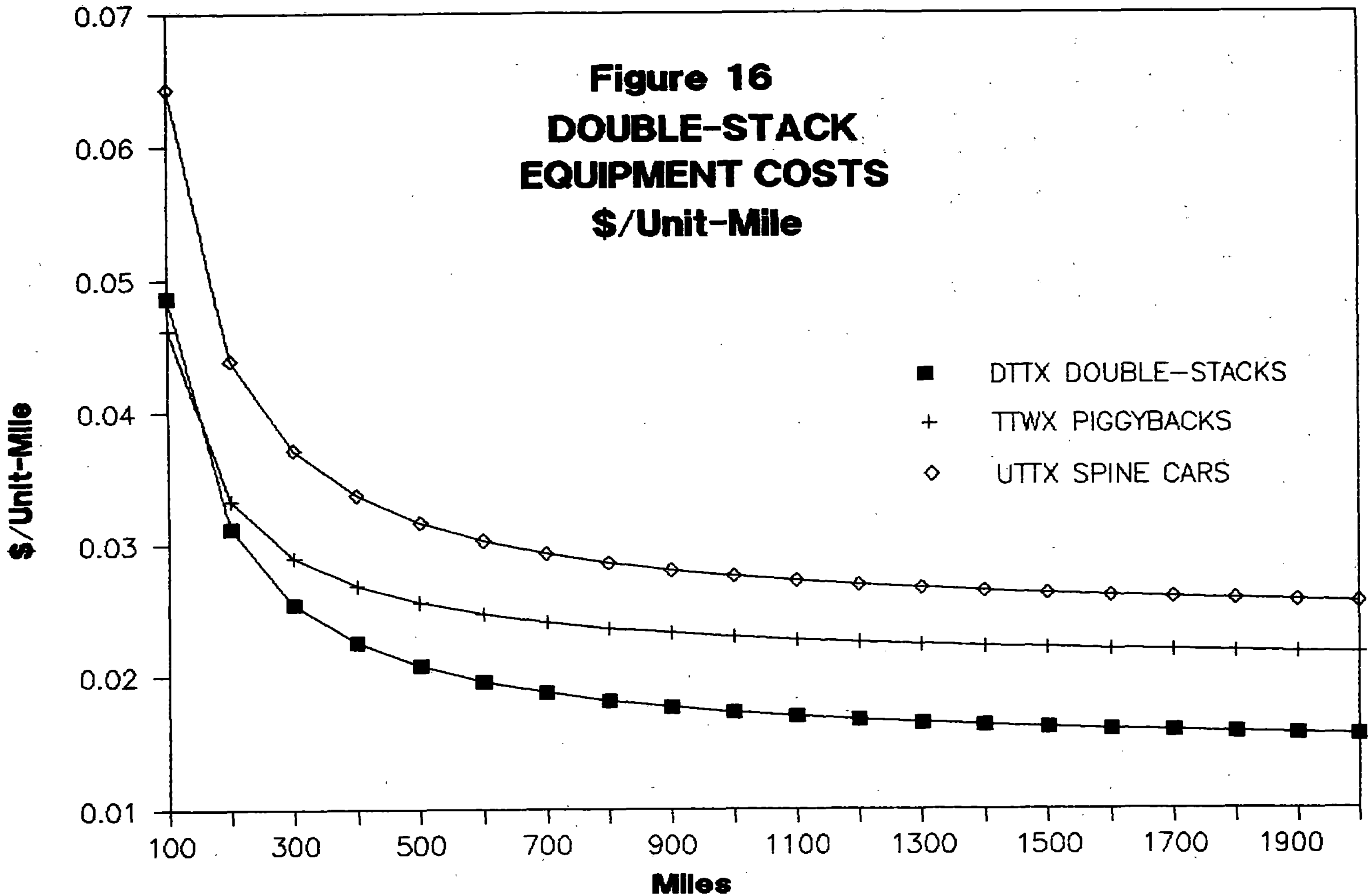
Figure 16 displays the relationship between equipment costs (cost per unit mile) and length of haul for double-stack (DTTX), conventional (TTWX), and Impack (UTTX) cars. The two trailer cars, UTTX and TTWX, have essentially parallel curves because they have the same unit mileage costs. The double-stack car has an intermediate fixed cost (on the vertical axis), but progressively lower per-mile unit costs because of its lower mileage charge. All three curves drop sharply between 100 and 700 miles, the effect of allocating the fixed terminal per diem expense over a progressively longer line-haul. Once the length of haul exceeds 700 - 900 miles, the curves are nearly flat.

Containers and Chassis. Containers or trailers are generally obtained either from leasing company pools or through long-term leases. The daily costs can differ significantly, as shown below:

Representative Container and Trailer Costs
\$/Day

	Pool	Lease	Breakeven Utilization
48' x 102" Container	\$ 6.50	\$ 4.90	75%
48' x 102" Trailer	\$ 12.50	\$ 7.25	58%

Source: Greenbrier Intermodal, American President Intermodal.



Source: Trailer Train Company

Pool costs include maintenance and storage. The lease costs shown are either for full-service leases or include an amount for maintenance, but do not include storage costs. The greatest difference is in risk and utilization. The use of pool equipment entails no risk, no management, and no responsibility when the equipment is not utilized. Long-term leases or ownership do entail risk, management, and the responsibility for seeing that the unit achieves acceptable utilization. Large carriers or multi-modals that can accept risk, manage the equipment, and achieve high utilization can obtain significant savings by leasing or owning equipment.

This study used the container pool per diem rates: \$6.50 per day for 48' x 102' container and \$8.00 per day for a chassis. The combined per diem for a container and chassis used in drayage, \$14.50, is higher than for a comparable trailer. To keep the cost of a container system lower, the chassis cannot be used in drayage or storage for more than 75 percent of the total door-to-door time. This limitation could be a problem in the shortest hauls, where terminal and drayage time together could approach or exceed 75 percent of the total.

4. Rail Labor Costs

Basis of Pay. Labor costs are the most complex factor in the cost simulation, and intermodal operations sometimes have separate labor agreements or other special provisions. Because this project considered through double-stack trains, there was no need to introduce the additional complexities of switching between terminals. Arbitraries (crew payments for specific tasks or delays in terminals) were not simulated, since their presence indicates either abnormal operations or a conscious decision on the railroad's part to incur arbitraries in place of some other cost. The three major remaining variables are the basis of pay, the crew size, and the length of crew districts. The following discussion and the labor costs used in the simulations are based on current agreements for a major railroad in the Pacific Northwest, considered typical of industry practice. The specific rates chosen are for "new hires", because such rates will predominate in the future.

The basis of pay involves both time and mileage, with the actual pay rate calculated on a mileage basis. The basic day's work is 8 hours and 108 miles. "Overmileage" is paid for miles exceeding 108. "Overtime" is paid for time between 8 hours and 12 hours (the absolute limit for on-the-road time), providing mileage also exceeds 108. The basis of pay is $0.94 per mile for a "new hire" brakeman, once he or she has reached 100 percent pay (pay starts at 75 percent on the date of hire). Overmileage is paid at about $0.85 per mile. All overtime hours are converted to miles, at 1.5 times the basic rate of 13.5 miles per hour (108 miles in 8 hours), or 20.25 mph. The minimum day's pay is 108 miles at $.94 per mile, or $101.52. The table below compares pay rates for brakemen, conductors, and engineers:

Typical Pay Rates, New Hires
$/Mile

	Brakeman	Conductor	Engineer
Basic Mileage	$ 0.94	$ 1.09	$ 1.31
Overmileage	$ 0.85	$ .90	$ 1.08

Source: Railroad industry contacts.

Crew Size. The four-person crew, consisting of two brakemen, a conductor, and an engineer, is still common. As shown below, the aggregate pay for a four-person crew is about $462.24 per 8-hour/108-mile day, and $3.68 per mile for overmileage:

Rail Labor Costs

	Crew Size		
	Two	Three	Four
Basic Day's Pay	$274.94	$384.33	$462.24
Overmileage	$1.98/mile	$2.83/mile	$3.68/mile
Basic Day's Cost*	$349.17	$488.10	$587.04
Overmileage Cost*	$2.51/mile	$3.59/mile	$4.67/mile

*With 27 percent payroll taxes and benefits.

Reducing the crew to three persons, as has become practical for many intermodal trains, usually involves some additional compensation for the remaining crew members, often called "productivity pay". Typical compensation is about $7.87 per person per trip. Pay rates for a three-person crew plus productivity pay yield about $384.33 per day and $2.83 per mile for overmileage. Some expedited intermodal trains and a very few double-stack trains operate with two-person crews, just a conductor and an engineer. Pay rates for such a crew, with productivity pay, would be about $274.94 per day and $1.98 per mile for over mileage. The minimum cost estimate used two-person crews, representing the minimum feasible labor expense. Recognizing that two-person crews will not be universal in the near future, each operation was also estimated with three-person and four-person crews.

To the basic pay rates discussed above must be added payroll taxes, benefits, and other non-pay labor costs. Various sources, including AAR summary publications and railroad R-1 reports, indicate that such costs range from 23 percent to 33 percent of wages and salaries for transportation (as opposed to maintenance or administration), with 27 percent being a typical value for the nation as a whole. The table above applies this 27 percent increase to the pay rates to derive labor costs for each crew size. These labor cost figures were used in the simulations.

Crew Districts. Railroads, particularly the western railroads, have made considerable progress on consolidating crew districts to obtain longer runs between crew changes. For decades, the basis of pay was 100 miles per day, and crew districts were roughly 100 miles long. Railroads have been gradually lengthening crew districts, preferring to pay one crew for extra mileage than to call another crew.

5. Rail Line-Haul Costs

Engineered Costing. Engineered line-haul costs were developed using Manalytics' Rail Cost Model (RCM), a computerized train performance simulator and costing algorithm. Engineered costing allows the researcher to simulate optimal conditions, thus illustrating the best potential cost performance that a given technology might deliver.

Assumptions. Train performance simulation requires numerous assumptions regarding technical performance factors and unit costs. For this study, typical values were selected for those factors common to rail operation of all types, such as locomotive specifications, fuel prices, wage rates, etc. Factors specific to intermodal operations, such as train length, crew size, and crew assignments, were tested for sensitivity.

All double-stack simulations used car specifications (weight, cross-section, etc.) from Gunderson "Maxi-Stack II" 125-ton IBC cars, typical of the most recent additions to the double-stack fleet. All trains were assumed to be carrying 48' x 102" domestic containers, whose specifications follow those of the APC fleet. Containers were assumed to be loaded to the car weight limit in both directions. All simulations used high-horsepower, 4-axle locomotives for road power and, where required, for helpers. All simulations were cabooseless.

No allowance was made for terminal switching. The need for terminal switching and the associated costs vary widely, depending on terminal size and configuration, train loading schedule, operating practices, and local labor agreements. In the optimal case being simulated here, the train is assumed to be handled intact at a large facility or simply "doubled" (split into two pieces on adjoining tracks) by the road crew.

Diesel fuel cost was estimated at $.3901 per gallon, the average price reported by the AAR for 1987, adjusted by the late 1988 AAR cost index. Incremental maintenance of way and structures is included in the RCM at $.00120 per gross ton-mile. This figure was derived from regression analysis performed during development of the RCM, adjusted to a 1988 equivalent using the ARR cost index for materials, supplies, labor, and supplements, excluding fuel.

Line-Haul Simulations. Simulations of multiple double-stack operating scenarios were prepared for two representative routes of different lengths: Los Angeles-New Orleans (2010.2 miles via SP) and Los Angeles-Oakland (559.4 miles via SP). Both routes cover a variety of terrain and operating conditions. Various combinations of train length, crew size, and crew district length were simulated for each route. For both routes, the base case simulation was a 20-car double-stack train with a 2-person crew operating over extended crew districts.

Table 10 gives the estimated line-haul cost per unit-mile (in this case the units are containers) for the Los Angeles-New Orleans simulation. The base case cost was estimated to be $0.118 per unit-mile, not including the costs of cars or containers. Cases 2 and 3 show the effects of train length on unit cost. Reducing the train to 15 cars did not allow a reduction in the number of locomotives or crew members, and produced a 15 percent increase in unit cost. Increasing the train to 28 cars required additional locomotives and/or helpers, which kept the net savings down to 4 percent. Adding a third and fourth crewman increased the unit cost by 5 and 9 percent, respectively. Addition of the fourth crewman resulted in a smaller incremental cost because lonesome pay was eliminated for the other three.

Case 6 simulated 2-person crews operating over short districts, typically 100-150 miles. Such operating methods would raise the unit cost by 3 percent over the practice of paying overmileage for fewer crews. Case 7 simulated a 4-person crew operating over short districts, a common practice not long ago and still prevalent in some areas. The larger crews and shorter districts would raise the cost by 13 percent over the base case. The effect is somewhat compounded by the slower schedule and greater fuel consumption caused by additional stops. Case 8, with a 15-car train, 4-person crews, and short crew districts, produced a unit cost of $0.156 per mile, 32 percent higher than the base case.

Table 11 gives the results of comparable simulations for the 559.4 mile Los Angeles-Oakland route. The base case, using the same assumptions of 20 cars, 2-person crews, and extended crew districts, yielded an estimate of $0.138 per unit mile (17 percent greater than the Los Angeles-New Orleans route).

Cases 2 and 3 simulated 15-car and 28-car trains with 2-person crews and extended districts, and yielded costs of $0.142 and $0.130 per mile, respectively. Cases 4 and 5 simulated 3-person and 4-person crews, and resulted in unit costs of $0.144 and $0.150 respectively. The unit cost

Table 10

RAIL LINE-HAUL COST ESTIMATES
LOS ANGELES-NEW ORLEANS
2010.2 Miles

Case		$/Unit Mile*	% Change
1.	Base Case: 20-car train, 2-person crews, extended districts	0.118	-
2.	15-car Train, 2-person crews, extended districts.	0.136	+15
3.	28-Car train, 2-person crews extended districts.	0.113	-4
4.	20-car train, 3-person crew, extended districts.	0.124	+5
5.	20-car train, 4-person crew, extended districts.	0.129	+9
6.	20-car train, 2-person crew, short districts.	0.121	+3
7.	20-car train, 4-person crew, short districts.	0.133	+13
8.	15-car train, 4-person crew, short districts.	0.156	+32

*Not including cars or containers.
Source: Manalytics' Rail Cost Model.

Table 11

RAIL LINE-HAUL COST ESTIMATES
LOS ANGELES-OAKLAND
559.4 Miles

Case		$/Unit Mile*	% Change
1.	Base Case: 20-car train, 2-person crews, extended districts	0.138	-
2.	15-car Train, 2-person crews, extended districts.	0.142	+3
3.	28-Car train, 2-person crews extended districts.	0.130	-6
4.	20-car train, 3-person crew, extended districts.	0.144	+4
5.	20-car train, 4-person crew, extended districts.	0.150	+9
6.	20-car train, 2-person crew, short districts.	0.143	+4
7.	20-car train, 4-person crew, short districts.	0.157	+14
8.	15-car train, 4-person crew, short districts.	0.185	+34

*Not including cars nor containers.
Source: Manalytics' Rail Cost Model.

increases, 4 percent and 9 percent, were essentially the same as for the longer haul. Shortening the crew districts in Cases 6-8 yielded unit costs ranging from $0.143 to $0.185 per mile, depending on crew size and train consist. The percentage increases were similar to those obtained for the Los Angeles-New Orleans simulation.

Line-Haul Cost Findings. The engineered line-haul cost estimates for double-stack trains range from $0.113 per unit-mile to $0.185 per unit-mile, depending on route, train size, crew size, and crew districts. The extreme low cost estimate represents a combination -- very long haul, 28-car train, 2-person crews, extended crew districts -- that is technically feasible but not currently available on any railroad. The extreme high cost estimate represents a combination -- very short haul, 15-car train, 4-person crews, short crew districts -- representative of only the least efficient current operations. Both extremes represent minimums of a kind, however, since neither allows for empty movements, delays, congestion, or other day-to-day variations from optimal performance.

An attainable standard for the near future is likely to resemble the Case 4 simulations on Tables 10 and 11: 20-car trains, 3-person crews, and extended districts. These simulations produced costs of $0.124 per unit mile on the long haul and $0.144 per mile on the short haul, 4-5 percent greater than the base cases and 20-22 percent below the highest cost cases.

Note that even this "attainable" standard assumes 100 percent loaded movement in both directions, an optimistic assumption for an optimal rail service. Actual double-stack arrivals in Los Angeles during 1987 had a reported loaded average of 80 percent westbound. Industry sources indicate that this number is inflated, however, due to the practice of reporting entire trains as loaded for billing purposes. Informal estimates put actual loads at about 60 percent of the westbound movement, but increasing. The lack of reliable utilization figures suggests that the prudent course is to simulate optimal performance and to consider the loaded/empty balance as a target for improvement.

6. Gathering and Distribution Costs

Drayage Costs. Intermodal containers must be moved by highway between inland rail hubs and the actual origins or destinations. Performed within the commercial zone of a city, this function is known as drayage or cartage, and is often provided by specialized firms. The central issue in drayage or short-haul trucking costs is stem time; the time required to pick up the intermodal equipment, move it to the shipper or consignee, load or unload it, and return it to the intermodal hub.

There are five major elements in the underlying cost of highway movements (exclusive of overhead or profit). Four of these five cost elements are based on time, rather than distance:

- annual or hourly cost of tractor ownership;
- annual or hourly cost of tractor maintenance;
- annual or hourly cost of license and insurance;
- hourly labor cost; and
- mileage-based fuel cost.

Annual ownership cost of a drayage tractor (which is not as elaborately equipped as a long-haul tractor) is approximately $12,000: $8,000 for the purchase (an $80,000 purchase price over 10 years, using straight-line depreciation and allowing for no residual) and $6,000 for interest (at a 15% cost of capital). The typical annual cost of maintenance is approximately $16,000. Thus, the annual cost of a fully maintained tractor is about $30,000. Normal yearly usage is about 225 days per tractor (52 weeks, 5 days per week, less 13 holidays and 22 days down time). Daily tractor cost is then $30,000/225, or $133.33 per day. For a ten-hour day, this figure equates to $13.33 per hour. Local non-union labor, with fringe benefits, averages about $11.00 per hour. Although some drayage is performed by union drivers, the non-union firms tend to set the competitive rate. Mid-1988 fuel costs were about $1.05 per gallon, and modern tractors get an average of 5.22 miles per gallon overall, giving a fuel cost of $.20 per mile.

The general calculation for the cost of drayage -- excluding the cost of the container and chassis -- would therefore be:

$13.33 (hours) + $11.00 (hours) + $.20 (miles)

This equation yields an over-the highway cost of $34.33, or $.69 per mile, at 50 miles per hour, nearly the same average as a truckload carrier. But relatively little of a drayman's time is spent on the highway. Within urban areas, the costs change. Drayage tractors burns fuel at about 1 gallon per hour while idling, and average mileage drops to about 3.5 miles per gallon in urban traffic. While idling in a terminal, the drayman's cost is about $25.38 per hour, and in urban traffic at 30 miles per hour it is about $33.33 per hour.

Drayage <u>rates</u> are set to recover the costs of mixed urban and highway movements, for which draymen typically charge a minimum of <u>$35.00 per hour</u>. The strong relationship between <u>time</u> and drayage costs has been observed empirically. In Southern California, for example, drayage from the Ports of Los Angeles or Long Beach to the SP ICTF (4 miles away) is roughly $35, reflecting time rather than distance. Drayage from the Ports to the UP ar ATSF facilities (20-25 miles away) is roughly $70, the difference of $35 being an additional hour's travel in urban traffic rather than 20 additional miles (which, by the estimates above, would cost only $13.80 at highway speeds).

The hours include time spent waiting in terminals, and time spent loading or unloading. Drayage rates usually allow two hours for loading or unloading. Delay beyond two hours is typically billed at about $32.50 per hour. Time in rail terminals can vary from 15 minutes in the newest and most efficient, to an hour or more in older or congested facilities. Thus, even the shortest trips are often priced at $70-80 round trip to allow for up to two hours of waiting. The low utilization involved in loading, unloading, and waiting yields very high cost for each mile travelled.

7. Double-Stack Terminal Costs

Double-stack services include substantial expenses on both ends of the trip for terminal transfer operations, chassis supply, and drayage. These costs are independent of line-haul trip length, but they can vary substantially between locations.

Lift Costs. Industry representatives provided a wide range of estimates for terminal costs, and references to other studies widened the range further. The most representative estimate, and the one chosen for use in this study, is $26 per lift for an all-inclusive "turnkey" contract operation (no railroad employees) at a major hub. This cost does not include amoritization of the underlying railroad assets, which was estimated at $8.00 to $10.00 per lift for a large, relatively new facility. The cost criteria use the minimum of $8.00 per lift, giving a minimum total terminal lift and facility cost of $34.00 per lift.

Chassis Costs. The per chassis costs from most neutral chassis pools range from $8.00 to $8.50 per day. Chassis on long-term leases can be priced as low as $2.00 per day, but long-term leases make the lessee responsible for maintenance, storage, and utilization. The growing popularity of neutral chassis pools suggests that, on balance, the $8.00 to $8.50 range is attractive to all but the largest customers. The cost criteria use the $8.00 minimum for one day at each end.

Drayage Costs. The drayage analysis yielded an estimated rate of $35.00 per hour. The length-of-haul analysis assumes a drayage distance of up to 30 miles, about half the width of a commercial zone or a metropolitan area. In major cities, round-trip drayage, including terminal pickup and loading or unloading, would require about 4 hours, for a cost of $140 on each end of the trip.

For purposes of identifying relevant truck traffic, we have defined five drayage zones, shown on Table 12 as Zone 0 through Zone 4. Zone 0 is the minimum assumed in the cost analysis. Zones 1 to 4 are one hour's drive, each way, broader than the previous zone. The additional hour's drive is assumed to be at 50 mph, being beyond the most congested zone and including

Table 12

DRAYAGE ZONES AND COSTS

	1-Way Miles	Max Time	Est. Rate*	Rate Per Mile	Rate Per Line-Haul Mile 500	1000	1500	2000
Zone 0	30	4 hrs	140	4.667	0.280	0.140	0.093	0.070
Zone 1	80	6 hrs	210	2.625	0.420	0.210	0.140	0.105
Zone 2	130	8 hrs	280	2.154	0.560	0.280	0.187	0.140
Zone 3	180	10 hrs	350	1.944	0.700	0.350	0.233	0.175
Zone 4	230	12 hrs	420	1.826	0.840	0.420	0.280	0.210

* At $35 per hour

no loading or terminal time. The cost per one-way mile (which is the portion that competes with truck carriage) drops as mileage increases, but the cost burden on the line-haul grows steadily. At the longest drayage distances, the drayage costs may exceed the line-haul costs.

Total Terminal Costs. Representative terminal costs per container for a minimum-cost door-to-door operation can be summarized as follows:

Terminal Lift & Facilities	\$ 34.00 x 2 =	\$ 68.00
Chassis (1 day each end)	\$ 8.00 x 2 =	\$ 16.00
Drayage (30 miles and 4 hours at each end)	\$140.00 x 2 =	\$280.00
Total		\$364.00

8. Double-Stack Operating Costs and Length of Haul

Double-Stack Operating Costs. To obtain the total cost of a door-to-door double-stack movement, one must add terminal costs, linehaul costs, car costs, and container costs. Table 13 shows such calculations for Case 4 attainable minimums for both routes. Line-haul car costs assume two days for Los Angeles-New Orleans and one day for Los Angeles-Oakland. Container costs assumes five days for Los Angeles-New Orleans (1 day load, 2 days line-haul, 1 day terminal, 1 day unload) and three days for Los Angeles-Oakland (1 day load, 1 day linehaul and terminal, 1 day unload). The costs of chassis, terminal lift, and dray are fixed.

Table 13 shows a dramatic total cost difference traceable to length of haul. Although the unit line-haul costs are slightly higher for shorter hauls, the big difference is in the division of fixed costs over line-haul miles. The estimated fixed costs of terminal lift, chassis, and drayage total \$364 per container. Over 2010 miles, this fixed cost averages \$.18 per mile. Over 559 miles, this fixed cost averages \$.65 per mile.

The total, door-to-door long-haul costs have an attainable value of \$.336 per unit-mile. The railroad costs, which usually do not include containers, chassis, or drayage, are about \$.17 per unit mile, indicating that these simulations represent a highly efficient, but feasible, opera-

Table 13

TOTAL DOUBLE-STACK OPERATING COSTS
$/Unit-Mile

Route	Line Haul $/unit mile	Line Haul Cost	Line Haul Car Cost	Terminal Car Cost	Container Cost	Terminal Lift	Chassis Cost	Drayage	Total	Total $/unit mile
L.A.-New Orleans										
2010.2 Miles 48 Hours	0.124	249.26	27.03	3.49	32.50	68.00	16.00	280.00	676.28	0.336
L.A.-Oakland										
559.4 Miles 15 Hours	0.144	80.55	10.62	3.49	19.50	68.00	16.00	280.00	478.16	0.855

tion below existing average costs. These costs are clearly competitive with truckload costs, even if a 15 percent rate discount is offered. Indeed, there is little disagreement that double-stack operations have a marked cost advantage over trucks for such long hauls.

The Los Angeles-Oakland trip yields an attainable cost of \$.855 per unit-mile, with a railroad-only cost of \$.29 per unit-mile. These costs would be marginally competitive with trucks if a 15 percent rate discount must be offered from a truckload cost of \$1.00 per mile, but not competitive at lower truck costs.

Costs and Length of Haul. Given these representative line-haul costs and a truck cost of \$.71 per mile, we can examine a general case for the minimum length of haul over which double-stack trains will be competitive with truckload carriers.

Rail fixed costs total \$393.49, including \$68.00 for terminal lift, \$16.00 for chassis, \$280.00 for drayage, \$3.49 for car costs at the terminal, and \$26.00 for four days of container per diem (for a short haul, but more than the 480 miles that can be travelled in one day). The line-haul cost of \$.144 per unit mile (Los Angeles-Oakland, Case 4) can be considered representative. Rail car costs include per diem charges of \$.0073 per unit mile (\$6.98 per day, divided by 24 hours at 40 mph, or 960 miles) and mileage charges of \$.0065 per unit mile, for a total of \$0.0138 per unit-mile. Total mileage costs are therefore \$.144 plus \$.0138, or \$.158. An estimated cost function for short-haul double-stack operations (no more than four days container time) would therefore be:

$$\text{Total cost} = \$393.49 + \$.158\, M_R$$
$$\text{where } M_R = \text{Rail line-haul miles}$$

where the rail miles include only the line-haul and the customer is within 30 miles of the rail hub.

Repositioning and Drayage. Both trucks and domestic containers ordinarily must be repositioned to secure loads. Carriers are sometimes fortunate enough to find return loads where they have just unloaded, but the average repositioning movement is substantial.

Table 14 gives average repositioning distances by mileage blocks for over 7,000 truck hauls in the NMTDB (outlying figures representing unusual operations were deleted from the data). In the shortest mileage block (700 - 1,000 miles, corresponding to much of the competitive range identified in the service criteria), trucks travel an average of 154 miles from the last unloading point to secure the next load. As Figure 17 shows, truckers are willing to reposition farther on long hauls. But, as Figure 18 shows, repositioning miles are a declining percentage of line-haul miles. In the lowest mileage block, truck repositioning averages 18 percent of the linehaul miles. This unutilized time reflects almost exactly the 80 percent overall utilization for truckload carriers, with a small margin for other causes.

NMTDB data from truckload carriers who reported unloading in Chicago showed an average length of haul of 1,730 miles and repositioning of 171 miles, roughly 10 percent of the line-haul. This percentage corresponds closely to the relationship shown in Table 14, although industrial traffic sources in the Chicago area are denser than the national average.

Domestic container repositioning will typically require drayage beyond the commercial zone (for which was allowed 30 miles and 4 hours as a fixed terminal cost). At $35 per hour and 50 mph (outside the commercial zone), drayage costs the double-stack customer $.70 per mile. Adding an "excess" drayage term to the rail cost formula yields the following:

$$393.49 + .158\ M_R + .70(2)D$$

where M_R = rail line-haul, and
D is the drayage beyond 30 miles.

Drayage and Minimum Length of Haul. A relationship between drayage and minimum length of haul can now be established. Equating door-to-door

Table 14

TRUCK REPOSITIONING MILES

Mileage Block	Average Haul	Average Repositioning
700 - 1,000	840	154
1,000 - 1,500	1,212	208
1,500 - 2,000	1,741	230
2,000+	2,496	239

Source: National Motor Transport Data Base.

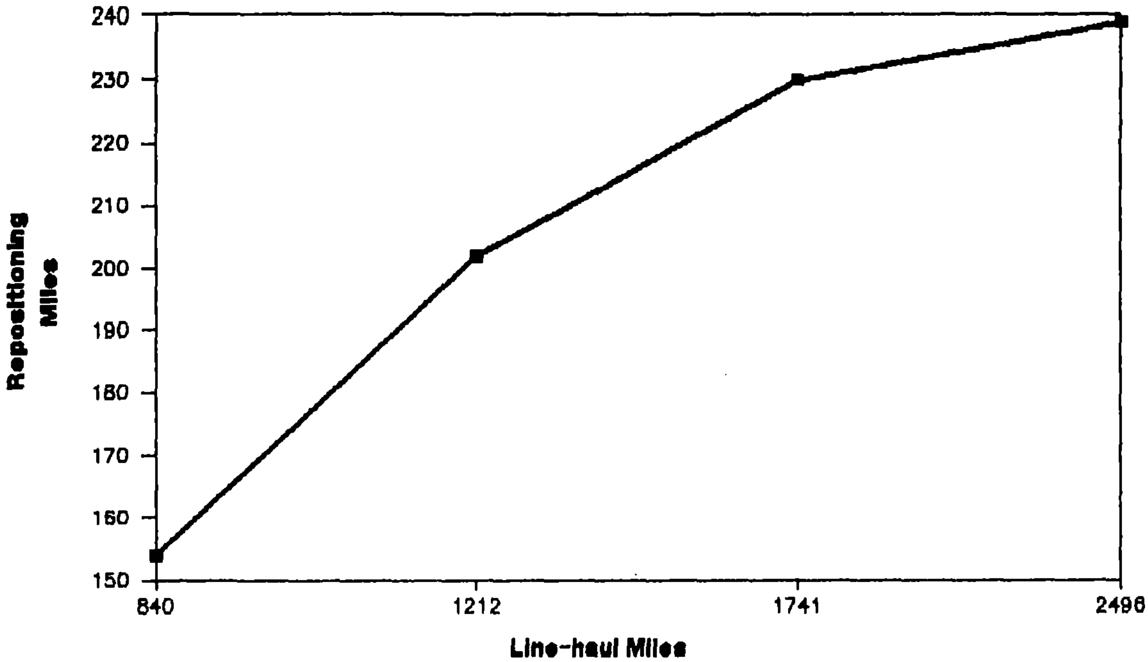


Figure 17: REPOSITIONING MILES Vs. TRUCK LINE-HAUL

Source: National Motor Transport Data Base

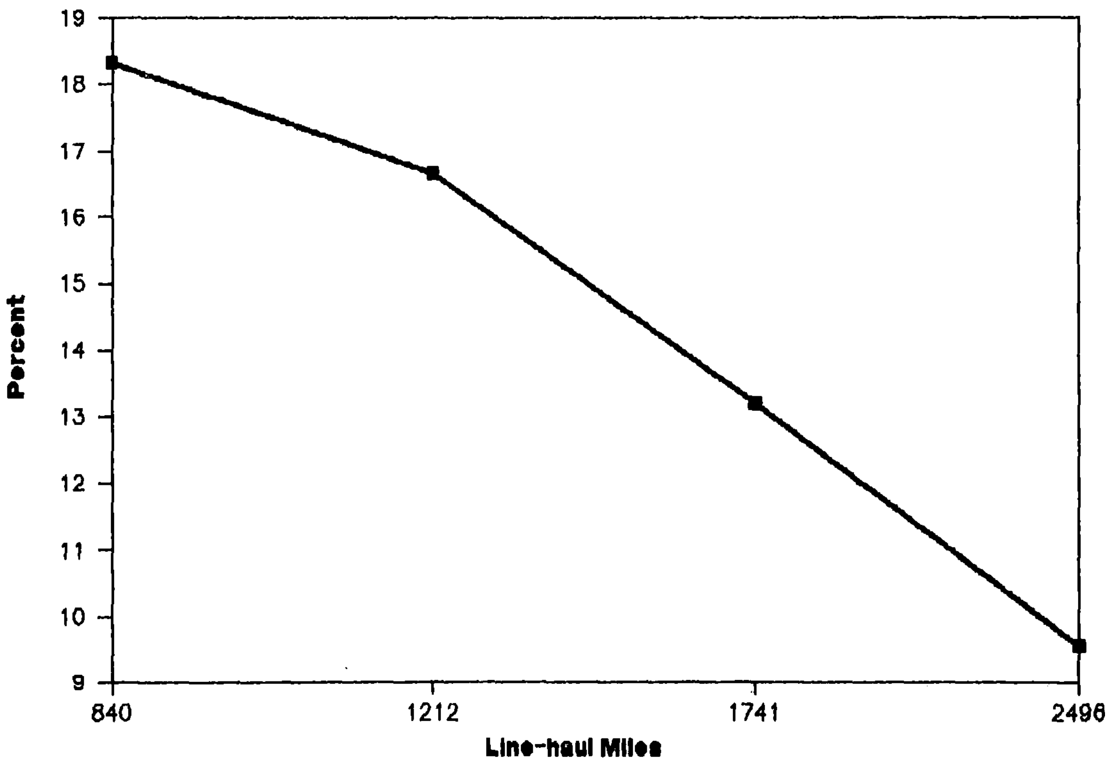


Figure 18: REPOSITIONING MILES / TRUCKLOAD LINE-HAUL (percent)

Source: National Motor Transport Data Base double-stack costs with 85 percent truckload costs (a 15 percent discount) yields:

$$393.49 + .158\ M_R + .70(2)D = .85(.89)\ M_T$$
where M_R = rail line-haul, and
M_T = truck line-haul

<u>A Caveat: Circuity</u>. Railroad and truck mileages are seldom the same, and in many instances are far enough apart to affect the ability of railroads to compete on short hauls. On long hauls, the cost advantage is great enough, and the transit time long enough, for the railroads to overcome a significant degree of circuitry. Moreover, circuitry as a percentage of total distance tends to decline as length of haul increases. The highway distance between Los Angeles and New Orleans is roughly 1883 miles, 10 percent less than the rail distance. On shorter hauls, however, the difference can be significant, even decisive. The distance over Southern Pacific's Central Valley route between Oakland and Los Angeles (used for SP's priority trains and thus for our cost analysis) is 559 miles. The highway distance is about 379 miles, 33 percent less. The railroad cannot be cost-competitive on that route. (SP's Coast Route is about 470 miles, still not cost-competitive.)

Table 15 compares rail and truck (highway) distances for some 200 city pairs representing major intermodal candidates. The rail mileage is actually shorter in a handful of cases (e.g., Chicago-Memphis or Kansas City-Detroit). On average, however, rail mileages are about 8 percent longer (more circuitous) than truck mileages.

Thus, truck mileage is typically about 92.6 percent (the reciprocal of 1.08) of rail mileage. This relationship allows the cost equation to be expressed in terms of rail line-haul mileage:

$$393.49 + .158\ (M_R) + .70(2)D = .85(.89)\ .926M_R$$
where M_R = rail line-haul
and D = drayage beyond 30 miles

Table 15
SELECTED RAIL AND HIGHWAY MILEAGES

Atlanta

	Rail	Highway	R/H
Atlanta			
Baltimore	676	645	1.05
Boston	1091	1037	1.05
Chicago	734	674	1.09
Cleveland	750	672	1.12
Dallas	825	795	1.04
Denver	1526	1398	1.09
Detroit	748	699	1.07
Houston	856	789	1.08
Indianapolis	585	493	1.19
Jacksonville	350	306	1.14
Kansas City	890	798	1.12
Los Angeles	2285	2182	1.05
Memphis	420	371	1.13
Miami	716	655	1.09
New Orleans	493	479	1.03
New York	862	841	1.02
Philadelphia	771	741	1.04
Pittsburgh	806	687	1.17
St Louis	612	541	1.13
St Paul	1130	1063	1.06
San Francisco	2718	2496	1.09
Seattle	2824	2618	1.08
AVERAGE RAIL CIRCUITY		1.088	

Chicago

	Rail	Highway	R/H
Atlanta	734	674	1.09
Baltimore	796	668	1.19
Boston	1018	963	1.06
Chicago			
Cleveland	340	335	1.01
Dallas	968	917	1.06
Denver	1026	996	1.03
Detroit	272	266	1.02
Houston	1205	1067	1.13
Indianapolis	184	181	1.02
Jacksonville	1083	980	1.11
Kansas City	451	499	0.90
Los Angeles	2227	2054	1.08
Memphis	527	530	0.99
Miami	1449	1329	1.09
New Orleans	921	912	1.01
New York	908	802	1.13
Philadelphia	816	738	1.11
Pittsburgh	468	452	1.04
St Louis	284	289	0.98
St Paul	396	395	1.00
San Francisco	2263	2142	1.06
Seattle	2141	2013	1.06
AVERAGE RAIL CIRCUITY		1.053	

Dallas

	Rail	Highway	R/H
Atlanta	825	795	1.04
Baltimore	1448	1356	1.07
Boston	1864	1748	1.07
Chicago	968	917	1.06
Cleveland	1234	1159	1.06
Dallas			
Denver	835	781	1.07
Detroit	1200	1143	1.05
Houston	264	243	1.09
Indianapolis	951	865	1.10
Jacksonville	1096	990	1.11
Kansas City	517	489	1.06
Los Angeles	1460	1387	1.05
Memphis	481	452	1.06
Miami	1462	1300	1.12
New Orleans	506	496	1.02
New York	1635	1552	1.05
Philadelphia	1543	1452	1.06
Pittsburgh	1291	1204	1.07
St Louis	711	630	1.13
St Paul	997	938	1.06
San Francisco	1930	1753	1.10
Seattle	2394	2078	1.15
AVERAGE RAIL CIRCUITY		1.075	

Jacksonville

	Rail	Highway	R/H
Atlanta	350	306	1.14
Baltimore	794	763	1.04
Boston	1210	1155	1.05
Chicago	1083	980	1.11
Cleveland	1100	915	1.20
Dallas	1096	990	1.11
Denver	1811	1704	1.06
Detroit	1098	1003	1.09
Houston	975	889	1.10
Indianapolis	935	799	1.17
Jacksonville			
Kansas City	1175	1104	1.06
Los Angeles	2578	2377	1.08
Memphis	691	674	1.03
Miami	366	349	1.05
New Orleans	612	555	1.10
New York	981	959	1.02
Philadelphia	890	859	1.04
Pittsburgh	1052	851	1.24
St Louis	917	847	1.08
St Paul	1479	1369	1.08
San Francisco	2989	2743	1.09
Seattle	3129	2924	1.07
AVERAGE RAIL CIRCUITY		1.092	

Kansas City

	Rail	Highway	R/H
Atlanta	890	798	1.12
Baltimore	1198	1048	1.14
Boston	1469	1391	1.06
Chicago	451	499	0.90
Cleveland	791	779	1.02
Dallas	517	489	1.06
Denver	636	600	1.06
Detroit	723	743	0.97
Houston	781	710	1.10
Indianapolis	518	485	1.07
Jacksonville	1175	1104	1.06
Kansas City			
Los Angeles	1776	1589	1.12
Memphis	484	451	1.07
Miami	1541	1448	1.06
New Orleans	873	806	1.08
New York	1329	1198	1.11
Philadelphia	1237	1118	1.11
Pittsburgh	889	838	1.06
St Louis	278	257	1.08
St Paul	480	449	1.07
San Francisc	1970	1835	1.07
Seattle	1954	1839	1.06
AVERAGE RAIL CIRCUITY		1.066	

Los Angeles

	Rail	Highway	R/H
Atlanta	2285	2182	1.05
Baltimore	2908	2636	1.10
Boston	3244	2979	1.09
Chicago	2227	2054	1.08
Cleveland	2555	2367	1.08
Dallas	1460	1387	1.05
Denver	1353	1059	1.28
Detroit	2499	2311	1.08
Houston	1641	1538	1.07
Indianapolis	2272	2073	1.10
Jacksonville	2578	2377	1.08
Kansas City	1776	1589	1.12
Los Angeles			
Memphis	1942	1817	1.07
Miami	2944	2687	1.10
New Orleans	1966	1883	1.04
New York	3082	2786	1.11
Philadelphia	2991	2706	1.11
Pittsburgh	2643	2426	1.09
St Louis	2032	1845	1.10
St Paul	2157	1894	1.14
San Francisco	470	379	1.24
Seattle	1370	1131	1.21
AVERAGE RAIL CIRCUITY		1.108	

Table 15
SELECTED RAIL AND HIGHWAY MILEAGES

New Orleans

	Rail	Highway	R/H
Atlanta	493	479	1.03
Baltimore	1154	1115	1.03
Boston	1569	1507	1.04
Chicago	921	912	1.01
Cleveland	1096	1030	1.06
Dallas	506	496	1.02
Denver	1341	1273	1.05
Detroit	1094	1045	1.05
Houston	363	356	1.02
Indianapolis	858	796	1.08
Jacksonville	612	555	1.10
Kansas City	873	806	1.08
Los Angeles	1966	1883	1.04
Memphis	394	390	1.01
Miami	978	856	1.14
New Orleans			
New York	1355	1311	1.03
Philadelphia	1264	1211	1.04
Pittsburgh	1152	1070	1.08
St Louis	699	673	1.04
St Paul	1273	1209	1.05
San Francisco	2436	2249	1.08
Seattle	2900	2574	1.13
AVERAGE RAIL CIRCUITY		1.056	

New York

	Rail	Highway	R/H
Atlanta	862	841	1.02
Baltimore	187	196	0.95
Boston	229	206	1.11
Chicago	908	802	1.13
Cleveland	571	473	1.21
Dallas	1635	1552	1.05
Denver	1934	1771	1.09
Detroit	648	637	1.02
Houston	1703	1608	1.06
Indianapolis	811	713	1.14
Jacksonville	981	959	1.02
Kansas City	1329	1198	1.11
Los Angeles	3082	2786	1.11
Memphis	1153	1100	1.05
Miami	1347	1308	1.03
New Orleans	1355	1311	1.03
New York			
Philadelphia	91	100	0.91
Pittsburgh	439	368	1.19
St Louis	1051	948	1.11
St Paul	1304	1197	1.09
San Francisco	3171	2934	1.08
Seattle	2739	2815	0.97
AVERAGE RAIL CIRCUITY		1.068	

San Francisco

	Rail	Highway	R/H
Atlanta	2718	2496	1.09
Baltimore	3059	2796	1.09
Boston	3281	3095	1.06
Chicago	2263	2142	1.06
Cleveland	2603	2467	1.06
Dallas	1930	1753	1.10
Denver	1374	1235	1.11
Detroit	2535	2399	1.06
Houston	2111	1912	1.10
Indianapolis	2429	2256	1.08
Jacksonville	2989	2743	1.09
Kansas City	1970	1835	1.07
Los Angeles	470	379	1.24
Memphis	2298	2125	1.08
Miami	3355	3053	1.10
New Orleans	2436	2249	1.08
New York	3171	2934	1.08
Philadelphia	3079	2866	1.07
Pittsburgh	2731	2578	1.06
St Louis	2189	2089	1.05
St Paul	2123	1945	1.09
San Francisco			
Seattle	900	808	1.11
AVERAGE RAIL CIRCUITY		1.088	

Seattle

	Rail	Highway	R/H
Atlanta	2824	2618	1.08
Baltimore	2937	2681	1.10
Boston	3159	2976	1.06
Chicago	2141	2013	1.06
Cleveland	2481	2348	1.06
Dallas	2394	2078	1.15
Denver	1554	1307	1.19
Detroit	2413	2279	1.06
Houston	2656	2274	1.17
Indianapolis	2325	2194	1.06
Jacksonville	3129	2924	1.07
Kansas City	1954	1839	1.06
Los Angeles	1370	1131	1.21
Memphis	2438	2290	1.06
Miami	3495	3273	1.07
New Orleans	2900	2574	1.13
New York	3049	2815	1.08
Philadelphia	2957	2751	1.07
Pittsburgh	2610	2465	1.06
St Louis	2213	2081	1.06
St Paul	1745	1618	1.08
San Francisco	900	808	1.11
Seattle			
AVERAGE RAIL CIRCUITY		1.094	

OVERALL AVERAGE RAIL CIRCUITY 1.079

This equation simplifies to:

$$725.30 + 2.58D = M_R$$

Therefore, without drayage beyond the commercial zone, a double-stack train with a line-haul of 725 miles can compete with a truckload haul of 671 miles (725 x .926). Although railroads may be able to offer competitive transit times on runs as short as 540 miles, the cost would be prohibitive. Thus, 725 miles is the minimum length of haul used in this study.

The table below shows the relationship and lengths of haul for drayage Zones 0 through 4 defined earlier:

Drayage and Length of Haul
For Double-Stack/Truckload Competition
Miles

Drayage Zone	One-Way Drayage Range	Truck Line-haul	Rail Line-haul
Zone 0	0- 30	671	725
Zone 1	30- 80	791	854
Zone 2	80-130	910	983
Zone 3	130-180	1,030	1,112
Zone 4	180-230	1,149	1,241

Figure 19 displays the relationship graphically. The area under the line is subject to competition from double-stacks under favorable assumptions: highly efficient operations and 100 percent loaded containers and cars in both directions. Only the most successful double-stack operators now approach either the cost or utilization assumptions used. These standards should be approached, however, by double-stack services seeking to be competitive with trucks on hauls as short as 725 miles.

This finding coincides with the results of the 1977 Census of Transportation, which found little rail market share in hauls of less than 500 miles, although 83 percent of the intercity merchandise moving by motor carrier was in such short hauls. Roughly 11 percent of the traffic was found to be

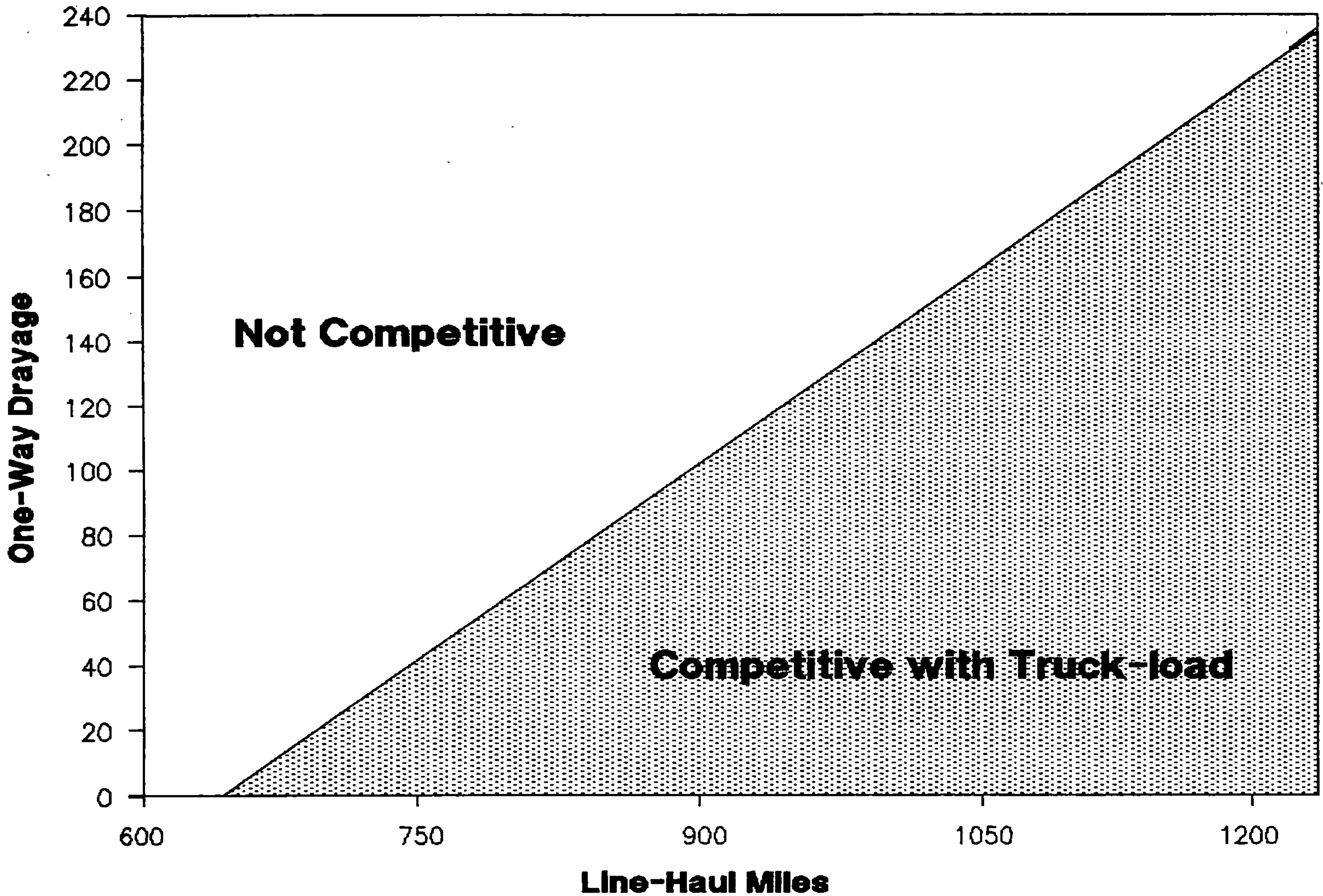


Figure 19: COMPETITIVE RAIL LINE-HAUL AT 8% CIRCUITY

in the 500-999 mile range, where this study found double-stack service to be truck-competitive, and the remaining 6 percent was in hauls of 1,000 miles or more, where double-stacks may have an advantage and where railroads have been found to hold a larger market share.

IV. DOUBLE-STACK NETWORKS

A. HYPOTHETICAL 1987 DOUBLE-STACK NETWORK

1. Major Corridors

Relevant data from the 1987 Carload Waybill Sample were examined to identify rail corridors 725 or more miles in length with sufficient containerizable rail traffic to initiate six-day-per-week double-stack trains of at least 15 cars each with a star-up threshold of 60 percent: that is, a minimum of 28,080 annual containers, trailers, or container equivalents. The corridors thus identified are listed in Table 16, and shown in Figure 20. Corridors were defined as flows between BEA Economic Areas (BEAs), each consisting of one or more major cities and surrounding territories defined by the Bureau of Economic Analysis.

In essence, these major corridors consist of eleven routes radiating from Chicago (Seattle, Portland, San Francisco-Oakland, Fresno-Bakersfield, Los Angeles, Dallas, Baltimore, Philadelphia, New York, Boston, and Quebec), and five more radiating from Los Angeles (Kansas City, Memphis, Dallas, New Orleans, and Houston). This network of hypothetical 1987 double-stack routes resembles the services actually available in 1989 (Figure 11). Many of these corridors already had double-stack service in 1987. Moreover, the same major hubs that have attracted international double-stack service have long attracted domestic piggyback and boxcar service.

The similarity between Figure 11 and Figure 20, however, can be misleading. The corridors shown in Figure 20, and listed in Table 16, are those determined to be potentially capable of initiating six-day-per-week, truck-competitive, dedicated double-stack service for domestic and international traffic. Current double-stack services, with only a few exceptions, are still based on international traffic flows, with the ability to compete with trucks for domestic flows a secondary consideration.

Routes to the Southeast, notably Atlanta, are conspicuously absent from Figure 20. The largest single candidate flow for that region, the Chicago-

RAIL TRAFFIC MEETING ANNUAL VOLUME CRITERIA OF 60 PERCENT OF 46,800 ANNUAL FEUS IN 1987
AND AT LEAST 725 MILES OF RAIL DISTANCE
BY ORIGIN BEA AND DESTINATION BEA WITH RAIL-HIGHWAY CIRCUITY APPENDED
SORTED BY ANNUAL FEUS
SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE

ORIGIN BEA NUMBER AND NAME		DESTINATION BEA NUMBER AND NAME		ANNUAL FEUS	ANNUAL NET TONS	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO
180	LOS ANGELES, CA	83	CHICAGO, IL	187,054	2,668,915	2,199	2,040	1.08
83	CHICAGO, IL	180	LOS ANGELES, CA	160,377	2,281,766	2,199	2,040	1.08
83	CHICAGO, IL	12	NEW YORK, NY	159,045	2,565,063	904	815	1.11
12	NEW YORK, NY	83	CHICAGO, IL	144,595	1,017,056	904	815	1.11
171	SEATTLE, WA	83	CHICAGO, IL	113,753	1,733,130	2,166	2,080	1.04
83	CHICAGO, IL	171	SEATTLE, WA	103,159	917,272	2,166	2,080	1.04
83	CHICAGO, IL	18	PHILADELPHIA, PA	79,559	1,336,916	836	785	1.06
83	CHICAGO, IL	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	59,385	799,948	2,222	2,120	1.05
83	CHICAGO, IL	4	BOSTON, MA	56,220	943,472	1,006	992	1.01
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	83	CHICAGO, IL	53,234	918,886	2,222	2,120	1.05
83	CHICAGO, IL	19	BALTIMORE, MD	49,160	786,084	811	773	1.05
122	HOUSTON, TX	180	LOS ANGELES, CA	45,798	870,728	1,630	1,564	1.04
83	CHICAGO, IL	125	DALLAS-FORT WORTH, TX	45,016	688,780	992	965	1.03
186	QUEBEC	83	CHICAGO, IL	40,220	700,380	835	851	0.98
4	BOSTON, MA	83	CHICAGO, IL	37,699	400,840	1,006	992	1.01
83	CHICAGO, IL	172	PORTLAND, OR	37,439	452,000	2,193	2,122	1.03
179	FRESNO-BAKERSFIELD, CA	83	CHICAGO, IL	37,107	774,148	2,301	2,154	1.07
180	LOS ANGELES, CA	55	MEMPHIS, TN	34,965	501,730	2,104	1,803	1.17
18	PHILADELPHIA, PA	83	CHICAGO, IL	34,806	469,200	836	785	1.06
172	PORTLAND, OR	83	CHICAGO, IL	34,333	715,140	2,194	2,122	1.03
180	LOS ANGELES, CA	122	HOUSTON, TX	34,324	558,792	1,630	1,564	1.04
172	PORTLAND, OR	180	LOS ANGELES, CA	32,390	734,640	1,091	960	1.14
19	BALTIMORE, MD	83	CHICAGO, IL	32,147	438,180	811	773	1.05
180	LOS ANGELES, CA	125	DALLAS-FORT WORTH, TX	31,753	467,492	1,639	1,438	1.14
180	LOS ANGELES, CA	105	KANSAS CITY, MO	29,818	468,400	1,739	1,618	1.07
105	KANSAS CITY, MO	180	LOS ANGELES, CA	29,799	493,628	1,739	1,618	1.07
180	LOS ANGELES, CA	113	NEW ORLEANS, LA	28,960	482,208	1,990	1,913	1.04

Table 16

Double Stack Network For Year 1987

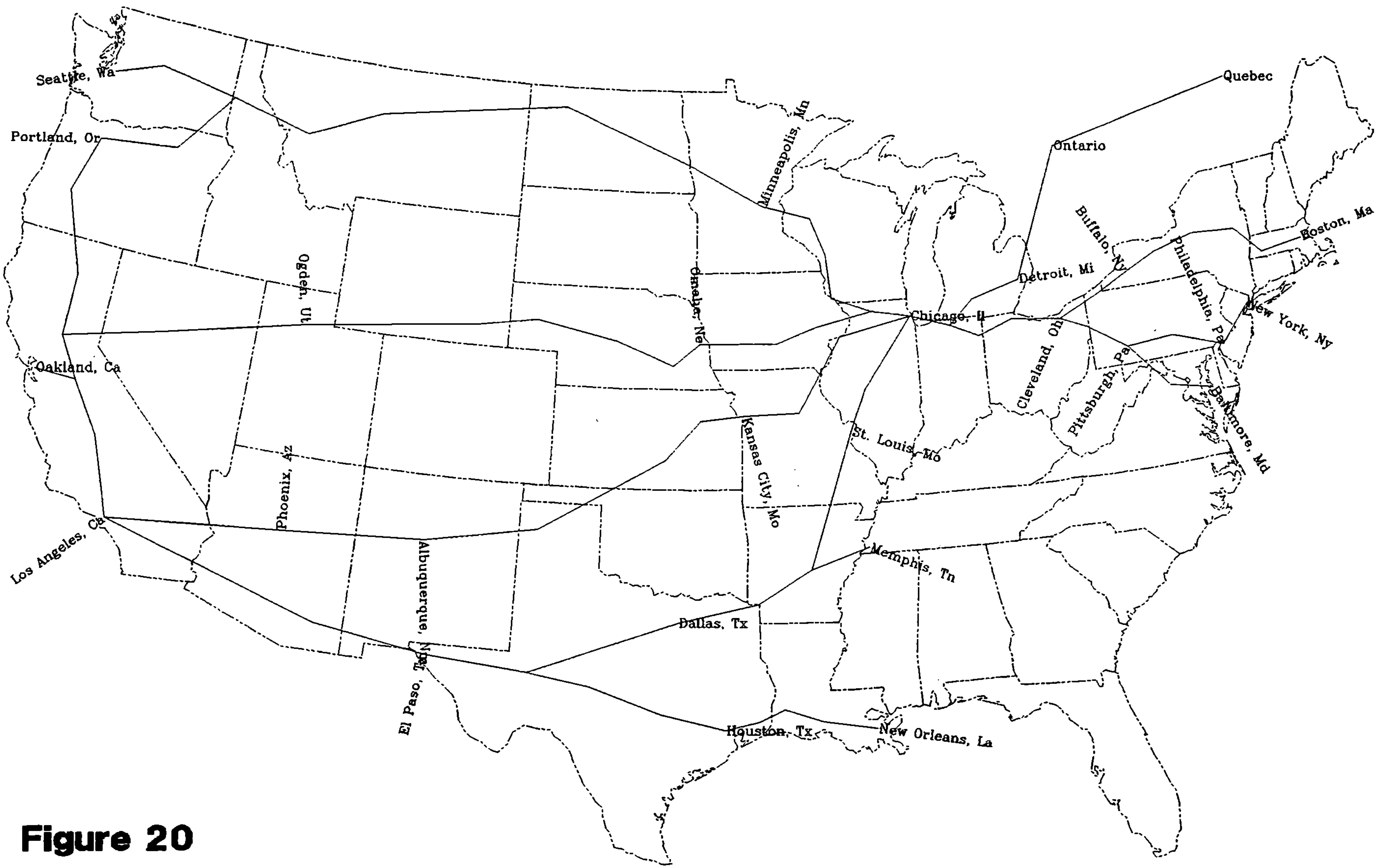


Figure 20

Atlanta traffic, is adequate in volume, but the distance is slightly short of the minimum length of haul derived from the operating cost criteria. Industry contacts indicate that the existing Chicago-Atlanta double-stack traffic consists largely of international and domestic traffic between Atlanta and the West Coast that has been rebilled at Chicago: there is little domestic double-stack traffic actually moving between Chicago and Atlanta. Intermodal traffic to and from Miami is dominated by the Jacksonville-Miami traffic carried by FEC, which, according to the cost criteria, does not travel far enough by rail to provide truck-competitive double-stack service.

There has, however, been substantial development of double-stack service to and from the Southeast since 1987. Atlanta is now served from Chicago and New Orleans, and further expansion seems likely. These services are based on international flows, but may nonetheless attract some domestic movements as backhauls.

The listing in Table 16 does not preclude railroads or third-parties from offering double-stack or mixed intermodal service in other corridors to attract boxcar traffic, or as a more efficient line-haul technology for piggyback traffic. It is possible that such services could divert a small amount of price-sensitive, low-service truck traffic. Such services, however, are not likely to achieve the volume needed to support truck-competitive, six-day-per-week service with just domestic traffic.

Other double-stack services will be offered, and several already are. The major corridors identified here do not include those that may carry weekly double-stack trains, or small blocks of double-stack cars, for major ocean carriers or other large customers.

2. Intermediate Points

Within an established service corridor, railroads offer service to, from, and between intermediate points, as long as each haul is at least 725 miles. A volume of one car (10 containers or equivalents) five days per week was set as the long-term minimum, and service was assumed to start at 60 percent of that minimum, giving a start-up threshold of 1560 annual units for intermediate points. Below this threshold, service would require the use of shorter cars (technically possible) or partial loading of cars (technically possible but inefficient and therefore unlikely to persist).

Table 17 lists the intermediate points that could potentially be served within the major double-stack corridors. Typically, one of the two BEAs is the end point of a major corridor: there is relatively little potential for movements between two secondary intermediate points. Figure 21 shows the increased density of the major double-stack corridors once the intermediate points are added.

Caveats. The network described for 1987 assumes that all containerizable traffic on those corridors is converted to double-stack containers. This assumption was not yet true in 1987, and is not likely to be true for several years. Some of the corridors shown on Figure 21 may not actually support frequent double-stack service as long as boxcars remain competitive in certain market niches. The Portland-Chicago and Fresno-Chicago flows, in particular, include significant amounts of boxcar traffic that may resist conversion to containers.

All of the network flows described in the preceding figures implicitly assume that the entire double-stack volume is available to one railroad in order to provide at least one service of the desired frequency. In the densest corridors there is enough traffic to support more than one service. But in the less dense corridors, every railroad may not be able to justify a double-stack departure every day.

The apparent position of the Chicago BEA as the preeminent shipper and receiver of potential double-stack traffic is deceptive. A large quantity of trailer traffic, and some container traffic, is drayed across Chicago between eastern and western railroads. Preliminary research by ALK Assoicates suggests that as much as 40 percent of the trailer traffic that "terminates" in Chicago is actually "rubber-tired" and becomes Chicago "originating" traffic within a few days, accounting for up to 1,000 movements per day, five days per week. The apparent West Coast - Chicago and East Coast - Chicago corridors conceal the existence of a larger through West Coast - East Coast movement than the Carload Waybill Sample

RAIL TRAFFIC TRAVELING ENTIRELY WITHIN CORRIDORS DEFINED BY 60 PERCENT OF ANNUAL FEUS IN 1987
AND WITH A RAIL DISTANCE OF AT LEAST 725 MILES
BY ORIGIN BEA AND DESTINATION BEA
SORTED BY DESCENDING ANNUAL FEUS
SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE

ORIGIN BEA NUMBER	AND NAME	DESTINATION BEA NUMBER	AND NAME	ANNUAL FEUS	ANNUAL NET TONS	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO
55	MEMPHIS, TN	180	LOS ANGELES, CA	27,539	417,796	2,104	1,803	1.17
173	EUGENE, OR	180	LOS ANGELES, CA	27,371	656,320	966	854	1.13
83	CHICAGO, IL	17	HARRISBURG-YORK-LANCASTER, PA	24,701	424,280	729	681	1.07
122	HOUSTON, TX	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	20,571	354,232	2,060	1,917	1.07
180	LOS ANGELES, CA	107	ST. LOUIS, MO	19,258	317,902	2,041	1,854	1.10
178	STOCKTON-MODESTO, CA	83	CHICAGO, IL	19,017	428,888	2,182	2,087	1.05
107	ST. LOUIS, MO	180	LOS ANGELES, CA	18,645	301,688	2,041	1,854	1.10
113	NEW ORLEANS, LA	180	LOS ANGELES, CA	17,840	321,856	1,990	1,913	1.04
83	CHICAGO, IL	6	HARTFORD-NEW HAVEN-SPRINGFLD, CT-MA	17,206	289,244	944	931	1.01
125	DALLAS-FORT WORTH, TX	83	CHICAGO, IL	16,086	245,996	992	965	1.03
83	CHICAGO, IL	165	SALT LAKE CITY-OGDEN, UT	13,933	191,460	1,485	1,405	1.06
171	SEATTLE, WA	12	NEW YORK, NY	12,223	166,780	3,071	2,892	1.06
83	CHICAGO, IL	162	PHOENIX AZ	12,058	148,752	1,818	1,810	1.00
180	LOS ANGELES, CA	172	PORTLAND, OR	11,651	175,056	1,091	960	1.14
71	DETROIT, MI	180	LOS ANGELES, CA	11,338	266,480	2,451	2,291	1.07
17	HARRISBURG-YORK-LANCASTER, PA	83	CHICAGO, IL	11,267	149,200	729	681	1.07
171	SEATTLE, WA	96	MINNEAPOLIS-ST. PAUL, MN	11,188	175,292	1,728	1,663	1.04
6	HARTFORD-NEW HAVEN-SPRINGFLD, CT-MA	83	CHICAGO, IL	10,508	108,080	944	931	1.01
113	NEW ORLEANS, LA	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	10,128	166,928	2,365	2,266	1.04
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	122	HOUSTON, TX	9,803	151,784	2,060	1,917	1.07
172	PORTLAND, OR	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	9,347	204,120	739	638	1.16
177	SACRAMENTO, CA	83	CHICAGO, IL	9,292	209,760	2,137	2,040	1.05
125	DALLAS-FORT WORTH, TX	180	LOS ANGELES, CA	8,997	140,952	1,639	1,438	1.14
169	RICHLAND, WA	83	CHICAGO, IL	8,887	205,820	1,996	1,945	1.03
71	DETROIT, MI	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	8,597	203,400	2,561	2,371	1.08
83	CHICAGO, IL	179	FRESNO-BAKERSFIELD, CA	8,418	76,510	2,301	2,154	1.07
96	MINNEAPOLIS-ST. PAUL, MN	171	SEATTLE, WA	8,260	104,680	1,728	1,663	1.04
71	DETROIT, MI	125	DALLAS-FORT WORTH, TX	7,778	179,780	1,246	1,209	1.03
55	MEMPHIS, TN	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	7,712	116,380	2,404	2,081	1.16
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	172	PORTLAND, OR	6,943	128,592	739	638	1.16
83	CHICAGO, IL	178	STOCKTON-MODESTO, CA	6,899	110,200	2,182	2,087	1.05
165	SALT LAKE CITY-OGDEN, UT	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	6,887	111,480	807	719	1.12
12	NEW YORK, NY	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	6,785	95,880	3,315	2,902	1.14
162	PHOENIX AZ	83	CHICAGO, IL	6,676	108,448	1,818	1,810	1.00
139	WICHITA, KS	180	LOS ANGELES, CA	6,563	129,016	1,569	1,495	1.05
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	125	DALLAS-FORT WORTH, TX	5,909	105,992	1,939	1,791	1.08
165	SALT LAKE CITY-OGDEN, UT	83	CHICAGO, IL	5,907	105,450	1,485	1,405	1.06
83	CHICAGO, IL	168	SPOKANE, WA	5,600	81,240	1,842	1,806	1.02
83	CHICAGO, IL	164	RENO, NV	5,434	71,240	1,982	1,904	1.04
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	113	NEW ORLEANS, LA	5,227	104,480	2,420	2,266	1.07
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	165	SALT LAKE CITY-OGDEN, UT	4,993	99,640	807	719	1.12
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	12	NEW YORK, NY	4,970	95,432	3,315	2,902	1.14
172	PORTLAND, OR	162	PHOENIX AZ	4,847	108,640	1,421	1,308	1.09
96	MINNEAPOLIS-ST. PAUL, MN	172	PORTLAND, OR	4,758	66,600	1,770	1,733	1.02
172	PORTLAND, OR	179	FRESNO-BAKERSFIELD, CA	4,653	111,440	817	754	1.08
125	DALLAS-FORT WORTH, TX	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	4,612	75,668	1,939	1,791	1.08
173	EUGENE, OR	162	PHOENIX AZ	4,585	109,480	1,351	1,202	1.12

Table 17

RAIL TRAFFIC TRAVELING ENTIRELY WITHIN CORRIDORS DEFINED BY 60 PERCENT OF ANNUAL FEUS IN 1987
AND WITH A RAIL DISTANCE OF AT LEAST 725 MILES
BY ORIGIN BEA AND DESTINATION BEA
SORTED BY DESCENDING ANNUAL FEUS
SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE

ORIGIN BEA NUMBER AND NAME		DESTINATION BEA NUMBER AND NAME		ANNUAL FEUS	ANNUAL NET TONS	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO
173	EUGENE, OR	83	CHICAGO, IL	4,498	107,260	2,319	2,236	1.04
105	KANSAS CITY, MO	162	PHOENIX AZ	4,482	74,040	1,359	1,362	1.00
71	DETROIT, MI	162	PHOENIX AZ	4,422	105,960	2,071	2,060	1.01
173	EUGENE, OR	12	NEW YORK, NY	4,418	106,020	3,245	3,018	1.08
135	AMARILLO, TX	180	LOS ANGELES, CA	4,257	85,440	1,219	1,078	1.13
172	PORTLAND, OR	96	MINNEAPOLIS-ST. PAUL, MN	4,047	82,060	1,777	1,733	1.03
178	STOCKTON-MODESTO, CA	9	ROCHESTER, NY	3,765	90,360	2,909	2,666	1.09
178	STOCKTON-MODESTO, CA	125	DALLAS-FORT WORTH, TX	3,746	85,992	1,861	1,757	1.06
170	YAKIMA, WA	83	CHICAGO, IL	3,653	80,260	2,074	2,003	1.04
178	STOCKTON-MODESTO, CA	12	NEW YORK, NY	3,582	85,720	3,223	2,869	1.12
179	FRESNO-BAKERSFIELD, CA	113	NEW ORLEANS, LA	3,536	76,420	2,161	2,113	1.02
111	LITTLE ROCK-N. LITTLE ROCK, AR	180	LOS ANGELES, CA	3,419	64,576	2,102	1,675	1.25
71	DETROIT, MI	171	SEATTLE, WA	3,333	62,320	2,493	2,360	1.06
96	MINNEAPOLIS-ST. PAUL, MN	18	PHILADELPHIA, PA	3,246	75,280	1,253	1,199	1.05
178	STOCKTON-MODESTO, CA	122	HOUSTON, TX	3,218	74,180	1,984	1,883	1.05
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	162	PHOENIX AZ	3,064	65,488	800	713	1.12
172	PORTLAND, OR	4	BOSTON, MA	3,060	72,260	3,222	3,081	1.05
171	SEATTLE, WA	18	PHILADELPHIA, PA	3,039	66,400	3,003	2,862	1.05
154	MISSOULA, MT	96	MINNEAPOLIS-ST. PAUL, MN	3,037	72,800	1,225	1,188	1.03
83	CHICAGO, IL	7	ALBANY-SCHENECTADY-TROY, NY	3,025	57,800	817	826	0.99
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	18	PHILADELPHIA, PA	3,019	70,320	3,247	2,886	1.13
83	CHICAGO, IL	160	ALBUQUERQUE, NM	2,977	35,600	1,383	1,344	1.03
83	CHICAGO, IL	177	SACRAMENTO, CA	2,960	44,640	2,137	2,040	1.05
180	LOS ANGELES, CA	133	ELPASO, TX	2,751	49,944	813	802	1.01
178	STOCKTON-MODESTO, CA	17	HARRISBURG-YORK-LANCASTER, PA	2,685	64,440	3,048	2,752	1.11
177	SACRAMENTO, CA	125	DALLAS-FORT WORTH, TX	2,648	57,880	2,145	1,802	1.19
19	BALTIMORE, MD	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,595	39,720	3,033	2,830	1.07
171	SEATTLE, WA	71	DETROIT, MI	2,575	46,160	2,493	2,360	1.06
173	EUGENE, OR	6	HARTFORD-NEW HAVEN-SPRINGFLD, CT-MA	2,560	61,440	3,285	3,134	1.05
180	LOS ANGELES, CA	160	ALBUQUERQUE, NM	2,530	39,528	893	796	1.12
154	MISSOULA, MT	180	LOS ANGELES, CA	2,520	60,480	1,330	1,243	1.07
187	ONTARIO	125	DALLAS-FORT WORTH, TX	2,488	59,000	1,483	1,438	1.03
187	ONTARIO	180	LOS ANGELES, CA	2,472	55,800	2,734	2,522	1.08
96	MINNEAPOLIS-ST. PAUL, MN	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,428	53,280	2,100	2,016	1.04
172	PORTLAND, OR	122	HOUSTON, TX	2,395	49,160	2,683	2,365	1.13
133	ELPASO, TX	83	CHICAGO, IL	2,368	40,440	1,386	1,601	0.87
187	ONTARIO	105	KANSAS CITY, MO	2,348	48,240	946	999	0.95
141	TOPEKA, KS	180	LOS ANGELES, CA	2,330	37,172	1,673	1,555	1.08
178	STOCKTON-MODESTO, CA	70	TOLEDO, OH	2,290	54,960	2,552	2,302	1.11
187	ONTARIO	107	ST. LOUIS, MO	2,215	41,840	734	768	0.96
169	RICHLAND, WA	88	ROCKFORD, IL	2,209	53,020	1,934	1,868	1.04
180	LOS ANGELES, CA	111	LITTLE ROCK-N. LITTLE ROCK, AR	2,190	27,590	2,102	1,675	1.25
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	55	MEMPHIS, TN	2,188	47,570	2,404	2,081	1.16
173	EUGENE, OR	4	BOSTON, MA	2,107	50,440	3,347	3,195	1.05
168	SPOKANE, WA	83	CHICAGO, IL	2,105	39,800	1,842	1,806	1.02
70	TOLEDO, OH	4	BOSTON, MA	2,067	34,280	781	768	1.02
71	DETROIT, MI	172	PORTLAND, OR	1,993	43,520	2,511	2,373	1.06

Table 17

RAIL TRAFFIC TRAVELING ENTIRELY WITHIN CORRIDORS DEFINED BY 60 PERCENT OF ANNUAL FEUS IN 1987
AND WITH A RAIL DISTANCE OF AT LEAST 725 MILES
BY ORIGIN BEA AND DESTINATION BEA
SORTED BY DESCENDING ANNUAL FEUS
SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE

ORIGIN BEA NUMBER	AND NAME	DESTINATION BEA NUMBER	AND NAME	ANNUAL FEUS	ANNUAL NET TONS	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO
173	EUGENE, OR	18	PHILADELPHIA, PA	1,982	47,480	3,177	3,002	1.06
187	ONTARIO	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,977	46,080	2,907	2,602	1.12
139	WICHITA, KS	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,960	37,200	1,869	1,751	1.07
178	STOCKTON-MODESTO, CA	55	MEMPHIS, TN	1,956	45,060	2,326	2,045	1.14
173	EUGENE, OR	20	WASHINGTON, DC	1,872	44,920	3,121	2,941	1.06
12	NEW YORK, NY	105	KANSAS CITY, MO	1,870	35,000	1,333	1,171	1.14
12	NEW YORK, NY	171	SEATTLE, WA	1,870	18,360	3,071	2,892	1.06
135	AMARILLO, TX	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,852	36,944	1,520	1,356	1.12
160	ALBUQUERQUE, NM	83	CHICAGO, IL	1,840	32,760	1,383	1,344	1.03
154	MISSOULA, MT	83	CHICAGO, IL	1,787	42,440	1,663	1,605	1.04
164	RENO, NV	83	CHICAGO, IL	1,760	37,440	1,982	1,904	1.04
178	STOCKTON-MODESTO, CA	4	BOSTON, MA	1,754	41,840	3,325	3,046	1.09
122	HOUSTON, TX	133	ELPASO, TX	1,745	22,080	817	762	1.07
71	DETROIT, MI	135	AMARILLO, TX	1,742	41,800	1,270	1,312	0.97
169	RICHLAND, WA	180	LOS ANGELES, CA	1,738	41,480	1,198	1,179	1.02
12	NEW YORK, NY	96	MINNEAPOLIS-ST. PAUL, MN	1,725	30,100	1,321	1,228	1.08
178	STOCKTON-MODESTO, CA	18	PHILADELPHIA, PA	1,720	41,280	3,155	2,853	1.11
105	KANSAS CITY, MO	160	ALBUQUERQUE, NM	1,688	28,120	931	896	1.04
178	STOCKTON-MODESTO, CA	113	NEW ORLEANS, LA	1,662	37,080	2,344	2,232	1.05
178	STOCKTON-MODESTO, CA	143	OMAHA, NE	1,660	32,240	1,730	1,604	1.08
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	88	ROCKFORD, IL	1,655	39,720	2,217	2,055	1.08
143	OMAHA, NE	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,605	33,080	1,787	1,637	1.09
105	KANSAS CITY, MO	65	CLEVELAND, OH	1,598	34,200	748	782	0.96

Table 17

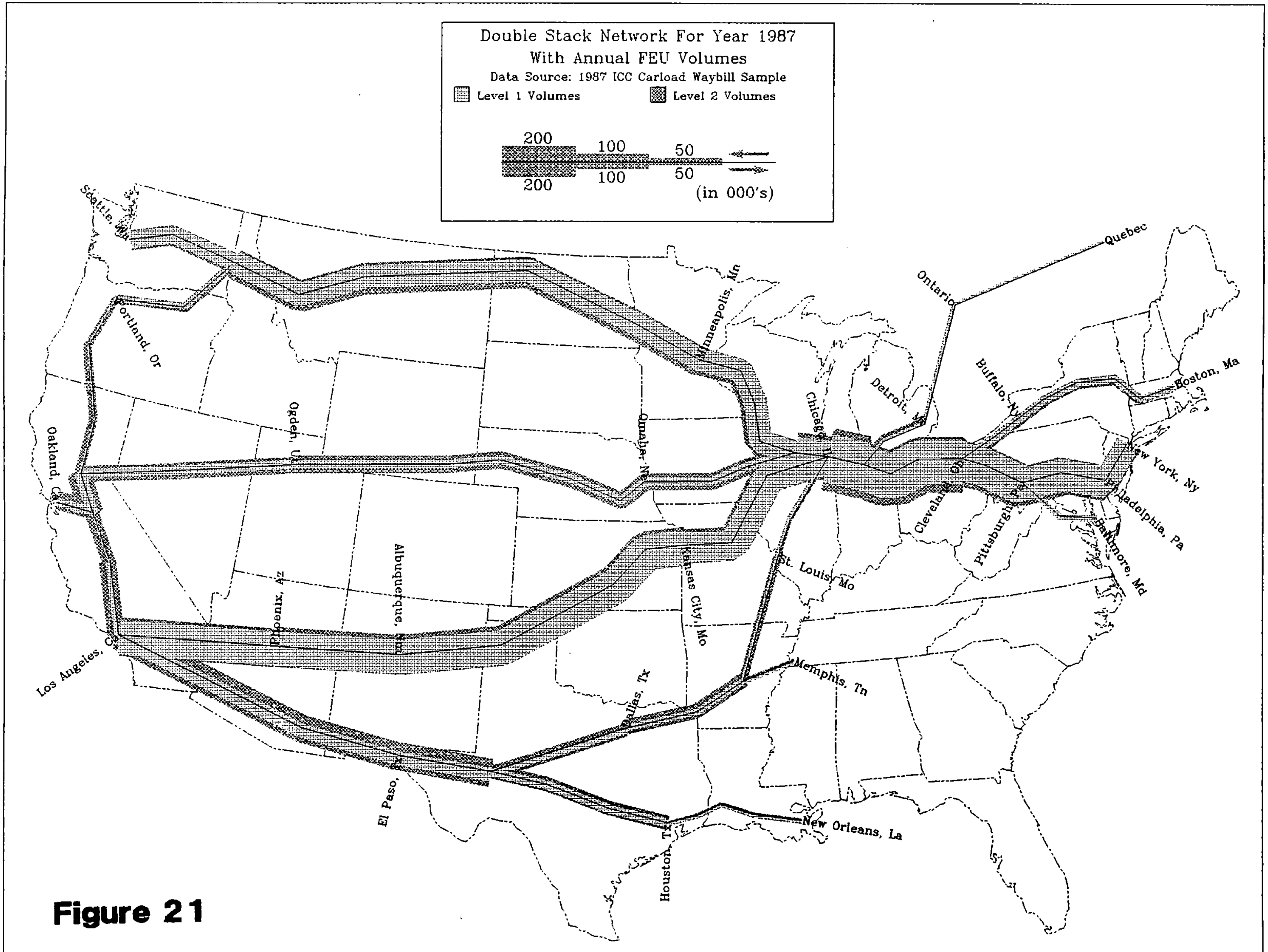

Double Stack Network For Year 1987
With Annual FEU Volumes
Data Source: 1987 ICC Carload Waybill Sample
Level 1 Volumes
Level 2 Volumes
200
100
50
50
100
200
(in 000's)
Seattle, Wa
Portland, Or
Oakland, Ca
Los Angeles, Ca
Ogden, Ut
Phoenix, Az
Albuquerque, Nm
El Paso, Tx
Minneapolis, Mn
Omaha, Ne
Kansas City, Mo
Dallas, Tx
Houston, Tx
Chicago, Il
St. Louis, Mo
Memphis, Tn
New Orleans, La
Detroit, Mi
Ontario
Quebec
Buffalo, Ny
Cleveland, Oh
Pittsburgh, Pa
Boston, Ma
New York, Ny
Philadelphia, Pa
Baltimore, Md

Figure 21

indicates. This practice will have to end if double-stack containers are to replace the "rubber-tired" trailers and compete successfully with trucks. The cost and service penalties imposed by rubber-tired interchanges would seriously handicap domestic double-stack services.

Rubber-tired interchanges and the practice of rebilling rail ("steel-wheeled") interchanges at major gateways such as Chicago and New Orleans appear to be responsible for the lack of complete data on some substantial flows. The actual Los Angeles-Atlanta intermodal flow, for example, is split in the data between Los Angeles-Atlanta, Los Angeles- New Orleans, and New Orleans-Atlanta figures. Perhaps as a result, the Los Angeles-Atlanta flow does not have sufficient apparent volume to be included in the truck-competitive network.

B. HYPOTHETICAL 1987 DOMESTIC AND INTERNATIONAL COMPONENTS

1. 1987 Domestic-Only Corridors

Table 18 lists the corridors that meet the volume and length-of-haul criteria on the basis of domestic traffic alone (or, more precisely, on the basis of Carload Waybill Sample data with no indication of being international). The list is short, much shorter than Table 16, because many corridors reach the volume required for truck-competitive service frequencies only by combining domestic and international traffic. The corridors are shown in Figure 22.

2. 1987 International-Only Corridors

Table 19 lists corridors that meet the volume and length-of-haul criteria based on Bureau of the Census data, and corridors that meet the same criteria based on import/export records identified in the Carload Waybill Sample. It is immediately clear from Table 19 that only a few major flows that could be identified from the data have sufficient volume to offer six-day-per-week truck-competitive service. The majority of international double-stack flows will continue to be driven primarily by import/export needs, rather than by any strategy of competing for domestic truck business. It is also clear from Table 19 that the data sources disagree.

BEA PAIRS OF ANNUAL DOMESTIC FEU VOLUMES QUALIFYING UNDER LEVEL1 CONDITIONS
BY ORIGIN AND DESTINATION BEA
SORTED BY DECREASING TOTAL OF DOMESTIC ANNUAL FEU VOLUMES
DATA SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE

ORIGIN BEA NUMBER AND NAME	DESTINATION BEA NUMBER AND NAME	RAIL DIST	HIWAY DIST	DOMESTIC FEUS	IMPORT FEUS	EXPORT FEUS	TOTAL FEUS
83 CHICAGO, IL	12 NEW YORK, NY	904	815	159,045	0	0	159,045
12 NEW YORK, NY	83 CHICAGO, IL	904	815	144,595	0	0	144,595
83 CHICAGO, IL	18 PHILADELPHIA, PA	836	785	79,559	0	0	79,559
180 LOS ANGELES, CA	83 CHICAGO, IL	2,199	2,040	63,682	22,101	101,271	187,054
83 CHICAGO, IL	180 LOS ANGELES, CA	2,199	2,040	59,301	101,076	0	160,377
171 SEATTLE, WA	83 CHICAGO, IL	2,166	2,080	56,553	56,456	744	113,753
83 CHICAGO, IL	4 BOSTON, MA	1,006	992	56,220	0	0	56,220
83 CHICAGO, IL	19 BALTIMORE, MD	811	773	49,160	0	0	49,160
186 QUEBEC	83 CHICAGO, IL	835	851	39,820	400	0	40,220
4 BOSTON, MA	83 CHICAGO, IL	1,006	992	37,699	0	0	37,699
83 CHICAGO, IL	171 SEATTLE, WA	2,166	2,080	37,099	0	66,060	103,159
172 PORTLAND, OR	180 LOS ANGELES, CA	1,091	960	32,390	0	0	32,390
18 PHILADELPHIA, PA	83 CHICAGO, IL	836	785	32,206	2,600	0	34,806
172 PORTLAND, OR	83 CHICAGO, IL	2,194	2,122	32,133	2,200	0	34,333
19 BALTIMORE, MD	83 CHICAGO, IL	811	773	32,107	40	0	32,147
122 HOUSTON, TX	180 LOS ANGELES, CA	1,630	1,564	30,430	15,368	0	45,798

Table 18

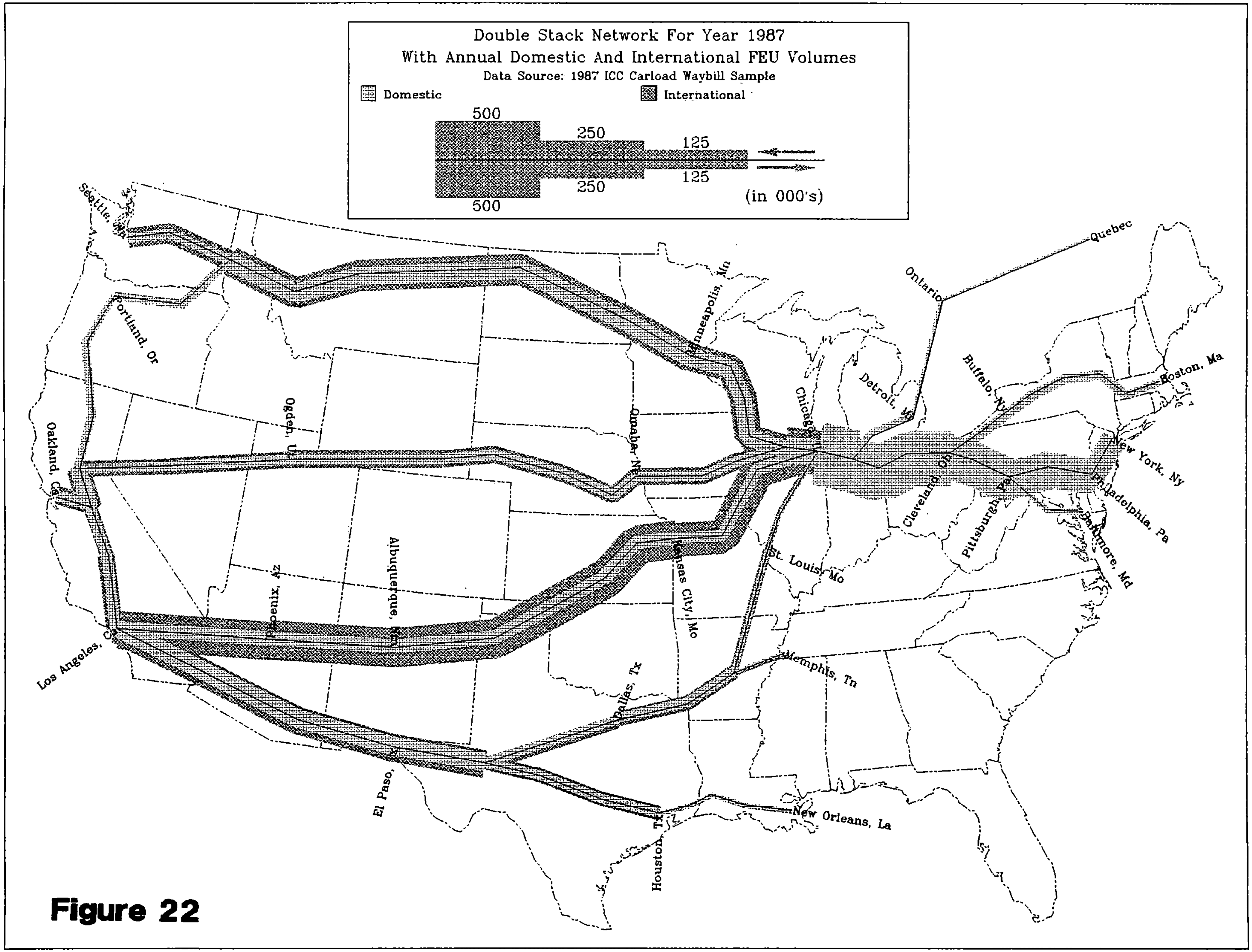

Double Stack Network For Year 1987
With Annual Domestic And International FEU Volumes
Data Source: 1987 ICC Carload Waybill Sample
Domestic
International
500
250
125
125
250
500
(in 000's)
Seattle, Wa
Portland, Or
Oakland, Ca
Los Angeles, Ca
Ogden, Ut
Phoenix, Az
Albuquerque, Nm
El Paso, Tx
Minneapolis, Mn
Omaha, Ne
Kansas City, Mo
Dallas, Tx
Houston, Tx
New Orleans, La
Memphis, Tn
St. Louis, Mo
Chicago, Il
Detroit, Mi
Ontario
Quebec
Buffalo, Ny
Cleveland, Oh
Pittsburgh, Pa
Boston, Ma
New York, Ny
Philadelphia, Pa
Baltimore, Md

Figure 22

Table 19
IDENTIFIABLE 1987 INTERNATIONAL NETWORK FLOWS
MEETING DISTANCE AND VOLUME CRITERIA

From the 1987 Carload Waybill Sample:

Origin BEA	Destination BEA	Import Containers	Export Containers	Total Containers
Los Angeles	Chicago	22,101	101,271	123,372
Chicago	Los Angeles	101,076	0	101,076
Chicago	Seattle	0	66,060	66,060
Seattle	Chicago	56,456	744	57,200
Chicago	San Francisco-Oakland	38,068	0	38,068
Fresno-Bakersfield	Chicago	0	35,472	35,471
San Francisco-Oak	Chicago	40	32,116	32,156

From the 1987 Bureau of the Census Data:

Origin BEA	Destination BEA	Import Containers	Export Containers	Total Containers
Seattle	Buffalo	39,139	1,581	40,720
Seattle	New York	31,921	679	32,600
Seattle	Chicago	27,697	6,913	34,610
Los Angeles	Buffalo	66,890	1,822	68,712
Los Angeles	New York	60,087	1,198	61,285
Los Angeles	Dallas-Ft Worth	28,250	26,437	54,687

C. HYPOTHETICAL 1987 TRUCK DIVERSIONS

1. Truck Diversion Methodology

A central issue in this study is the extent to which domestic double-stack container services might divert traffic from truckload motor carriers. Competition between truckload motor carriers and conventional piggyback services is already intense. In the long run, the ability of double-stacks to compete with trucks will determine not only whether they will be able to increase their share of the relevant market, but also whether railroads will be able to retain their present market share.

The service and cost criteria developed in this study were explicitly designed to identify potentially truck-competitive double-stack services. The cost criteria were expressed as a relationship between length of rail haul, length of truck haul, and cost of drayage (expressed as a series of distance zones). At issue is the total cost of drayage on both ends of the trip; a short, economical dray at origin will permit a larger dray at destination, and vice versa. Total cost limitations, however, will not permit long, expensive drays at both ends of the double-stack line haul. It is possible under some circumstances for the dray on one end to be very long indeed: drays of 250 miles or even longer are sometimes observed. But, it is not currently possible for double-stack operations to incorporate two long drays and still remain within a truck-competitive cost and service envelope.

To identify the actual traffic that might be affected, these drayage patterns were converted to geographic equivalents. After considering several options, it was determined that Metropolitan Statistical Areas (MSAs) are a workable equivalent to the Zone Ø drayage areas. There are 266 MSAs, each defined by a central city and selected surrounding counties (except in New England, where they are defined in terms of cities and towns). The 266 MSAs do not cover the entire nation, but are defined so as to encompass major population centers. The most workable geographic equivalents to Drayage Zone 4, with a one-way drayage range of up to 230 miles, are BEA Economic Areas (BEAs). BEAs are defined by clusters of counties around one or more prominent city. BEAs cover the entire nation, and typically incorporate one or more MSAs, together with surrounding counties.

Double-stack line-haul services can justify drayage over MSAs on both ends, over an MSA on one end and a BEA on the other, but <u>not</u> over entire BEAs on both ends (Figure 23). TRAM searched the NMTDB for data on dry and refrigerated truckload movements corresponding to potential 1987 corridors for truck-competitive double-stack services (Figure 20). Some flows, such as Chicago-Dallas, did not show up in the data due to the pattern of truckload movements or the structure of the data base. The movements thus identified were sorted into MSA's and BEA's to determine if they fit a feasible drayage pattern.

2. Truck Diversion Results

Appendix Table 6 lists the NMTDB truck movements that met the criteria set forth above. MSA's have been aggregated into BEA's to yield BEA-to-BEA flows comparable to the rail flows given in earlier tables. The results are shown in Figure 24. <u>These results indicate that significant truck diversions have already taken place in the major, well-established double-stack corridors</u>. We would otherwise expect to see much larger truck volumes in major corridors such as Los Angeles-Chicago. The 1987 truckload traffic in double-stack corridors is substantially lower than expected. Accordingly, the 1988 NMTDB data were examined to determine if the 1987 data had yielded an anomaly: the 1988 results verified the 1987 results.

<u>Effects of Truck Diversion on the Double-Stack Network</u>. Table 20 lists the rail and truck volumes (units) on the major double-stack corridors identified in Table 16. Table 20 provides a second perspective on some of the major flows. Between Los Angeles and Chicago, over 70 percent of the relevant traffic is already on the railroads in the form of container, piggyback, and containerizable boxcar traffic. To the extent that this body of traffic can be considered the relevant market, rail is already the majority mode. Moreover, the rail share is roughly the same in both directions. The situation between Los Angeles and Houston is markedly different, with the rail share apparently much higher westbound than eastbound. These shares suggest that the greatest potential for double-stack share growth between Los Angeles and Houston is the diversion

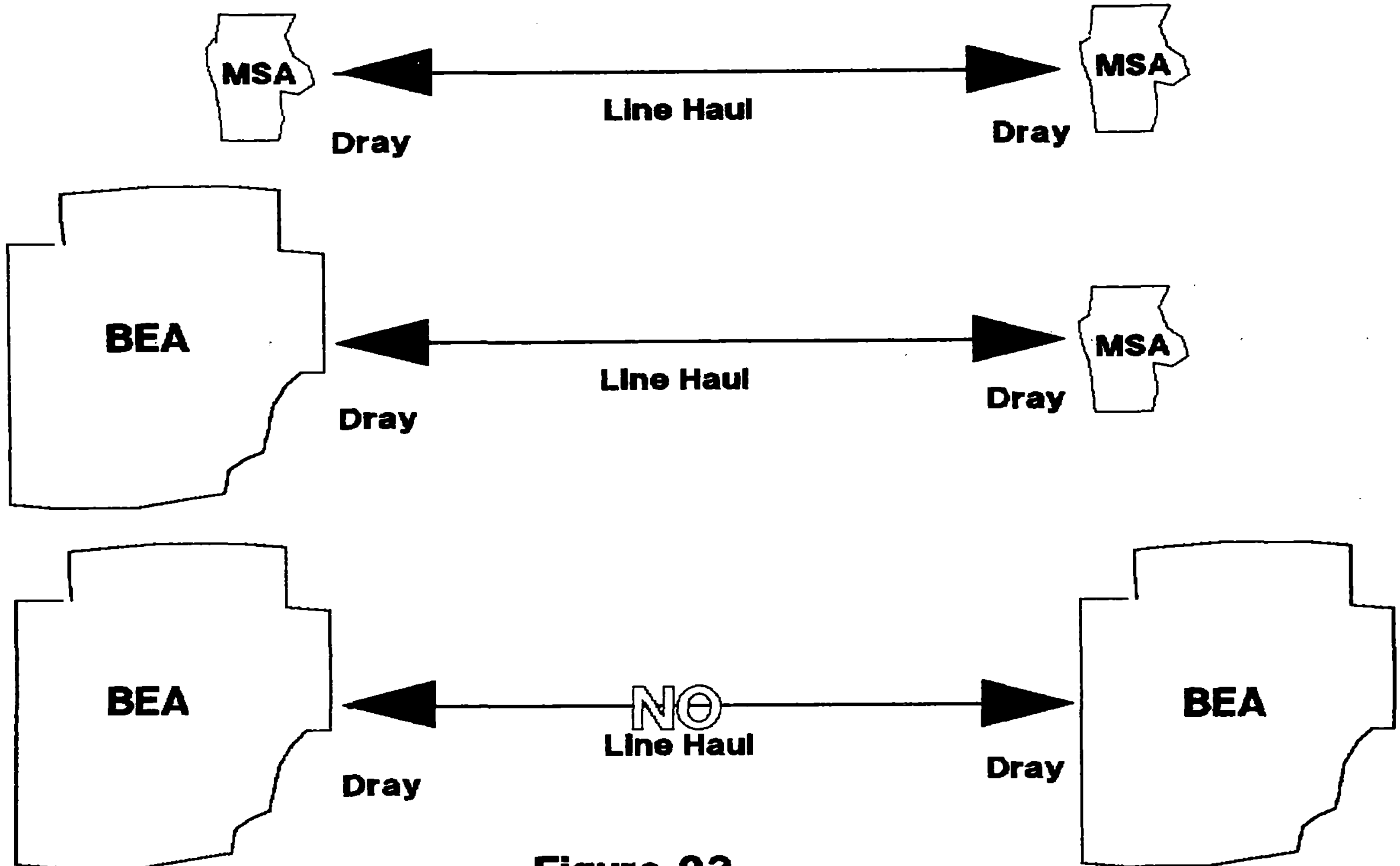
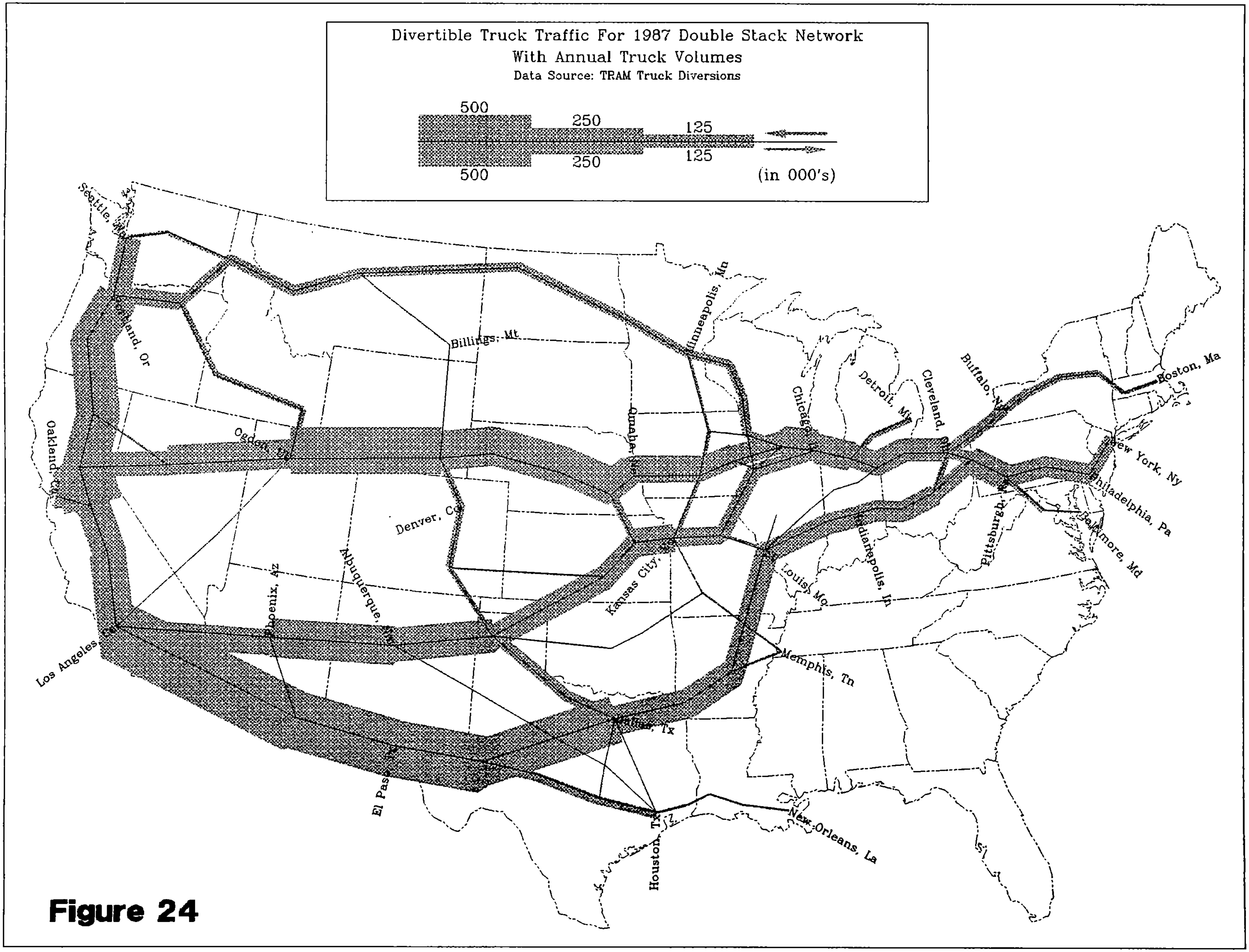


Figure 23

GEOGRAPHIC DRAYAGE PATTERNS



Divertible Truck Traffic For 1987 Double Stack Network
With Annual Truck Volumes
Data Source: TRAM Truck Diversions
500
250
125
125
250
500
(in 000's)
Portland, Or
Billings, Mt
Minneapolis, Mn
Oakland, Ca
Ogden, Ut
Omaha
Chicago
Detroit, Mi
Cleveland
Buffalo
Boston, Ma
New York, Ny
Philadelphia, Pa
Baltimore, Md
Pittsburgh
Indianapolis, In
Denver, Co
Kansas City
Louis, Mo
Memphis, Tn
Los Angeles
Phoenix, Az
Albuquerque
El Paso
Houston
New Orleans, La

Figure 24

DOUBLE STACK RAIL NETWORK DEFINED BY RAIL HAUL OF AT LEAST 725 MILES
AND ANNUAL FEU VOLUME OF AT LEAST 60 PERCENT OF 46,800
WITH DIVERTED FEU VOLUMES FROM TRAM DATA
SORTED BY DESCENDING ANNUAL FEUS
DATA SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE AND ANNUALIZED TRAM TRUCK VOLUMES

ORIGIN BEA NUMBER AND NAME	DESTINATION BEA NUMBER AND NAME	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO	RAIL FEUS	TRAM FEUS	TOTAL FEUS
180 LOS ANGELES, CA	83 CHICAGO, IL	2,199	2,040	1.08	187,054	67,500	254,554
83 CHICAGO, IL	180 LOS ANGELES, CA	2,199	2,040	1.08	160,377	44,352	204,729
83 CHICAGO, IL	12 NEW YORK, NY	904	815	1.11	159,045	0	159,045
12 NEW YORK, NY	83 CHICAGO, IL	904	815	1.11	144,595	0	144,595
171 SEATTLE, WA	83 CHICAGO, IL	2,166	2,080	1.04	113,753	0	113,753
83 CHICAGO, IL	171 SEATTLE, WA	2,166	2,080	1.04	103,159	0	103,159
83 CHICAGO, IL	18 PHILADELPHIA, PA	836	785	1.06	79,559	0	79,559
83 CHICAGO, IL	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,222	2,120	1.05	59,385	61,308	120,693
83 CHICAGO, IL	4 BOSTON, MA	1,006	992	1.01	56,220	0	56,220
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	83 CHICAGO, IL	2,222	2,120	1.05	53,234	0	53,234
83 CHICAGO, IL	19 BALTIMORE, MD	811	773	1.05	49,160	0	49,160
122 HOUSTON, TX	180 LOS ANGELES, CA	1,630	1,564	1.04	45,798	8,664	54,462
83 CHICAGO, IL	125 DALLAS-FORT WORTH, TX	992	965	1.03	45,016	0	45,016
186 UNKNOWN	83 CHICAGO, IL	835	851	0.98	40,220	0	40,220
4 BOSTON, MA	83 CHICAGO, IL	1,006	992	1.01	37,699	0	37,699
83 CHICAGO, IL	172 PORTLAND, OR	2,193	2,122	1.03	37,439	24,696	62,135
179 FRESNO-BAKERSFIELD, CA	83 CHICAGO, IL	2,301	2,154	1.07	37,107	8,088	45,195
180 LOS ANGELES, CA	55 MEMPHIS, TN	2,104	1,803	1.17	34,965	25,872	60,837
18 PHILADELPHIA, PA	83 CHICAGO, IL	836	785	1.06	34,806	0	34,806
172 PORTLAND, OR	83 CHICAGO, IL	2,194	2,122	1.03	34,333	12,348	46,681
180 LOS ANGELES, CA	122 HOUSTON, TX	1,630	1,564	1.04	34,324	68,016	102,340
172 PORTLAND, OR	180 LOS ANGELES, CA	1,091	960	1.14	32,390	63,156	95,546
19 BALTIMORE, MD	83 CHICAGO, IL	811	773	1.05	32,147	0	32,147
180 LOS ANGELES, CA	125 DALLAS-FORT WORTH, TX	1,639	1,438	1.14	31,753	88,992	120,745
180 LOS ANGELES, CA	105 KANSAS CITY, MO	1,739	1,618	1.07	29,818	7,368	37,186
105 KANSAS CITY, MO	180 LOS ANGELES, CA	1,739	1,618	1.07	29,799	0	29,799
180 LOS ANGELES, CA	113 NEW ORLEANS, LA	1,990	1,913	1.04	28,960	18,504	47,464
					1,732,115	498,864	2,230,979

Table 20

of eastbound truck traffic or the conversion of other eastbound rail traffic.

Table 21 provides an expanded list of corridors that might support truck competitive domestic double-stack service if some or all of the potential truck traffic were added to the rail volume, effectively "boot strapping" the required volume. The expanded corridor network is shown in Figure 25. Generally speaking, the additional corridors are incremental extensions of the basic network: new combinations of BEAs already served, or links to secondary markets.

Table 22 lists the rail and truck volumes for intermediate points in the network with more than 1560 annual rail units. New combinations result from the additional corridors shown in Figure 25. The addition of truck traffic would not add new intermediate points to the basic network, because if there are less than 1560 units of potential rail intermodal traffic, there would not be sufficient volume on which to begin a new truck-competitive service.

Eastern U.S. Truck Data. None of the foregoing tables list relevant truck traffic on eastern U.S. corridors such as Chicago-Boston or Chicago-New York. Although such traffic certainly exists, its volume cannot be reliably determined from any available data.

For truck data, this study relies on the National Motor Transportation Data Base (NMTDB), which is the only usable source of current data on the origins, destinations, commodities, types, and volumes of truck transportation. (The data collected by USDA on truck shipments of fresh fruits and vegetables are far too narrow; the 1977 Commodity Transportation Survey is dated and seriously limited in scope.) The NMTDB was created to identify rail-competitive truck movements of 800 miles or more. However, the cost criteria developed for this study imply a minimum length of haul of 725 miles, which is below the design threshold for the NMTDB.

The heavily industrialized portion of the Northeast is largely contained in a rough rectangle drawn between Boston, Milwaukee, St. Louis, and Baltimore (Figure 26). The NMTDB was designed to identify truck movements in or out

DOUBLE STACK RAIL NETWORK DEFINED BY RAIL HAUL OF AT LEAST 725 MILES
AND ANNUAL TRAM PLUS WAYBILL FEU VOLUME OF AT LEAST 60 PERCENT OF 46,800
WITH DIVERTED FEU VOLUMES FROM TRAM DATA
SORTED BY DESCENDING ANNUAL TOTAL FEUS
DATA SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE AND ANNUALIZED TRAM TRUCK VOLUMES

ORIGIN BEA NUMBER AND NAME	DESTINATION BEA NUMBER AND NAME	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO	RAIL FEUS	TRAM FEUS	TOTAL FEUS
180 LOS ANGELES, CA	83 CHICAGO, IL	2,199	2,040	1.08	187,054	67,500	254,554
83 CHICAGO, IL	180 LOS ANGELES, CA	2,199	2,040	1.08	160,377	44,352	204,729
125 DALLAS-FORT WORTH, TX	180 LOS ANGELES, CA	1,639	1,438	1.14	8,997	156,084	165,081
83 CHICAGO, IL	12 NEW YORK, NY	904	815	1.11	159,045	0	159,045
12 NEW YORK, NY	83 CHICAGO, IL	904	815	1.11	144,595	0	144,595
180 LOS ANGELES, CA	12 NEW YORK, NY	3,106	2,789	1.11	25,983	96,192	122,175
180 LOS ANGELES, CA	125 DALLAS-FORT WORTH, TX	1,639	1,438	1.14	31,753	88,992	120,745
83 CHICAGO, IL	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,222	2,120	1.05	59,385	61,308	120,693
180 LOS ANGELES, CA	171 SEATTLE, WA	1,274	1,133	1.12	4,141	112,008	116,149
171 SEATTLE, WA	83 CHICAGO, IL	2,166	2,080	1.04	113,753	0	113,753
83 CHICAGO, IL	171 SEATTLE, WA	2,166	2,080	1.04	103,159	0	103,159
180 LOS ANGELES, CA	122 HOUSTON, TX	1,630	1,564	1.04	34,324	68,016	102,340
172 PORTLAND, OR	180 LOS ANGELES, CA	1,091	960	1.14	32,390	63,156	95,546
180 LOS ANGELES, CA	172 PORTLAND, OR	1,091	960	1.14	11,651	82,404	94,055
83 CHICAGO, IL	18 PHILADELPHIA, PA	836	785	1.06	79,559	0	79,559
125 DALLAS-FORT WORTH, TX	162 PHOENIX, AZ	1,328	1,080	1.23	2,742	71,448	74,190
171 SEATTLE, WA	180 LOS ANGELES, CA	1,274	1,133	1.12	6,223	56,940	63,163
83 CHICAGO, IL	172 PORTLAND, OR	2,193	2,122	1.03	37,439	24,696	62,135
180 LOS ANGELES, CA	55 MEMPHIS, TN	2,104	1,803	1.17	34,965	25,872	60,837
12 NEW YORK, NY	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	3,315	2,902	1.14	6,785	51,672	58,457
83 CHICAGO, IL	4 BOSTON, MA	1,006	992	1.01	56,220	0	56,220
18 PHILADELPHIA, PA	180 LOS ANGELES, CA	3,038	2,734	1.11	2,022	53,520	55,542
122 HOUSTON, TX	180 LOS ANGELES, CA	1,630	1,564	1.04	45,798	8,664	54,462
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	83 CHICAGO, IL	2,222	2,120	1.05	53,234	0	53,234
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	171 SEATTLE, WA	923	811	1.14	1,033	50,928	51,961
83 CHICAGO, IL	19 BALTIMORE, MD	811	773	1.05	49,160	0	49,160
180 LOS ANGELES, CA	113 NEW ORLEANS, LA	1,990	1,913	1.04	28,960	18,504	47,464
180 LOS ANGELES, CA	4 BOSTON, MA	3,221	3,034	1.06	6,781	40,476	47,257
12 NEW YORK, NY	180 LOS ANGELES, CA	3,106	2,789	1.11	12,463	34,716	47,179
71 DETROIT, MI	180 LOS ANGELES, CA	2,451	2,291	1.07	11,338	35,496	46,834
172 PORTLAND, OR	83 CHICAGO, IL	2,194	2,122	1.03	34,333	12,348	46,681
179 FRESNO-BAKERSFIELD, CA	83 CHICAGO, IL	2,301	2,154	1.07	37,107	8,088	45,195
83 CHICAGO, IL	125 DALLAS-FORT WORTH, TX	992	965	1.03	45,016	0	45,016
178 STOCKTON-MODESTO, CA	125 DALLAS-FORT WORTH, TX	1,861	1,757	1.06	3,746	40,080	43,826
178 STOCKTON-MODESTO, CA	171 SEATTLE, WA	883	804	1.10	207	43,272	43,479
171 SEATTLE, WA	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	923	811	1.14	1,797	39,132	40,929
180 LOS ANGELES, CA	160 ALBUQUERQUE, NM	893	796	1.12	2,530	38,136	40,666
125 DALLAS-FORT WORTH, TX	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,939	1,791	1.08	4,612	35,688	40,300
186 UNKNOWN	83 CHICAGO, IL	835	851	0.98	40,220	0	40,220
55 MEMPHIS, TN	180 LOS ANGELES, CA	2,104	1,803	1.17	27,539	12,288	39,827
180 LOS ANGELES, CA	96 MINNEAPOLIS-ST. PAUL, MN	2,143	1,936	1.11	1,508	36,840	38,348
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	172 PORTLAND, OR	739	638	1.16	6,943	30,852	37,795
4 BOSTON, MA	83 CHICAGO, IL	1,006	992	1.01	37,699	0	37,699
180 LOS ANGELES, CA	105 KANSAS CITY, MO	1,739	1,618	1.07	29,818	7,368	37,186
162 PHOENIX, AZ	125 DALLAS-FORT WORTH, TX	1,328	1,080	1.23	602	35,832	36,434
105 KANSAS CITY, MO	165 SALT LAKE CITY-OGDEN, UT	1,138	1,055	1.08	3,588	32,784	36,372
18 PHILADELPHIA, PA	83 CHICAGO, IL	836	785	1.06	34,806	0	34,806

Table 21

DOUBLE STACK RAIL NETWORK DEFINED BY RAIL HAUL OF AT LEAST 725 MILES
AND ANNUAL TRAM PLUS WAYBILL FEU VOLUME OF AT LEAST 60 PERCENT OF 46,800
WITH DIVERTED FEU VOLUMES FROM TRAM DATA
SORTED BY DESCENDING ANNUAL TOTAL FEUS
DATA SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE AND ANNUALIZED TRAM TRUCK VOLUMES

ORIGIN BEA NUMBER AND NAME	DESTINATION BEA NUMBER AND NAME	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO	RAIL FEUS	TRAM FEUS	TOTAL FEUS
83 CHICAGO, IL	164 RENO, NV	1,982	1,904	1.04	5,434	28,524	33,958
19 BALTIMORE, MD	83 CHICAGO, IL	811	773	1.05	32,147	0	32,147
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	105 KANSAS CITY, MO	2,017	1,770	1.14	7,286	24,696	31,982
180 LOS ANGELES, CA	71 DETROIT, MI	2,451	2,291	1.07	857	30,768	31,625
173 EUGENE, OR	180 LOS ANGELES, CA	966	854	1.13	27,371	4,140	31,511
178 STOCKTON-MODESTO, CA	83 CHICAGO, IL	2,182	2,087	1.05	19,017	12,348	31,365
9 ROCHESTER, NY	180 LOS ANGELES, CA	2,819	2,619	1.08	410	30,444	30,854
105 KANSAS CITY, MO	180 LOS ANGELES, CA	1,739	1,618	1.07	29,799	0	29,799
180 LOS ANGELES, CA	20 WASHINGTON, DC	3,010	2,664	1.13	160	28,320	28,480
					1,945,881	1,844,892	3,790,773

Table 21

DOUBLE STACK RAIL NETWORK DEFINED BY RAIL HAUL OF AT LEAST 725 MILES WHOLLY WITHIN CORRIDORS DEFINED BY ANNUAL FEU VOLUME OF 60 PERCENT OF 46,800
AND ANNUAL FEU VOLUME OF AT LEAST 60 PERCENT OF 2,600
WITH DIVERTED FEU VOLUMES FROM TRAM DATA
SORTED BY DESCENDING ANNUAL FEUS
DATA SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE AND ANNUALIZED TRAM TRUCK VOLUMES

ORIGIN BEA NUMBER AND NAME	DESTINATION BEA NUMBER AND NAME	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO	RAIL FEUS	TRAM FEUS	TOTAL FEUS
55 MEMPHIS, TN	180 LOS ANGELES, CA	2,104	1,803	1.17	27,539	12,288	39,827
173 EUGENE, OR	180 LOS ANGELES, CA	966	854	1.13	27,371	4,140	31,511
83 CHICAGO, IL	17 HARRISBURG-YORK-LANCASTER, PA	729	681	1.07	24,701	0	24,701
122 HOUSTON, TX	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,060	1,917	1.07	20,571	0	20,571
180 LOS ANGELES, CA	107 ST. LOUIS, MO	2,041	1,854	1.10	19,258	0	19,258
178 STOCKTON-MODESTO, CA	83 CHICAGO, IL	2,182	2,087	1.05	19,017	12,348	31,365
107 ST. LOUIS, MO	180 LOS ANGELES, CA	2,041	1,854	1.10	18,645	8,664	27,309
113 NEW ORLEANS, LA	180 LOS ANGELES, CA	1,990	1,913	1.04	17,840	9,840	27,680
83 CHICAGO, IL	6 HARTFORD-NEW HAVEN-SPRINGFLD, CT-MA	944	931	1.01	17,206	0	17,206
125 DALLAS-FORT WORTH, TX	83 CHICAGO, IL	992	965	1.03	16,086	0	16,086
83 CHICAGO, IL	165 SALT LAKE CITY-OGDEN, UT	1,485	1,405	1.06	13,933	8,088	22,021
171 SEATTLE, WA	12 NEW YORK, NY	3,071	2,892	1.06	12,223	0	12,223
83 CHICAGO, IL	162 PHOENIX, AZ	1,818	1,810	1.00	12,058	12,612	24,670
180 LOS ANGELES, CA	172 PORTLAND, OR	1,091	960	1.14	11,651	82,404	94,055
71 DETROIT, MI	180 LOS ANGELES, CA	2,451	2,291	1.07	11,338	35,496	46,834
17 HARRISBURG-YORK-LANCASTER, PA	83 CHICAGO, IL	729	681	1.07	11,267	0	11,267
171 SEATTLE, WA	96 MINNEAPOLIS-ST. PAUL, MN	1,728	1,663	1.04	11,188	0	11,188
6 HARTFORD-NEW HAVEN-SPRINGFLD, CT-MA	83 CHICAGO, IL	944	931	1.01	10,508	0	10,508
113 NEW ORLEANS, LA	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,365	2,266	1.04	10,128	0	10,128
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	122 HOUSTON, TX	2,060	1,917	1.07	9,803	4,920	14,723
172 PORTLAND, OR	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	739	638	1.16	9,347	8,904	18,251
177 SACRAMENTO, CA	83 CHICAGO, IL	2,137	2,040	1.05	9,292	12,348	21,640
125 DALLAS-FORT WORTH, TX	180 LOS ANGELES, CA	1,639	1,438	1.14	8,997	156,084	165,081
169 RICHLAND, WA	83 CHICAGO, IL	1,996	1,945	1.03	8,887	0	8,887
71 DETROIT, MI	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,561	2,371	1.08	8,597	0	8,597
83 CHICAGO, IL	179 FRESNO-BAKERSFIELD, CA	2,301	2,154	1.07	8,418	0	8,418
96 MINNEAPOLIS-ST. PAUL, MN	171 SEATTLE, WA	1,728	1,663	1.04	8,260	0	8,260
71 DETROIT, MI	125 DALLAS-FORT WORTH, TX	1,246	1,209	1.03	7,778	0	7,778
55 MEMPHIS, TN	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,404	2,081	1.16	7,712	0	7,712
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	172 PORTLAND, OR	739	638	1.16	6,943	30,852	37,795
83 CHICAGO, IL	178 STOCKTON-MODESTO, CA	2,182	2,087	1.05	6,899	0	6,899
165 SALT LAKE CITY-OGDEN, UT	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	807	719	1.12	6,887	0	6,887
12 NEW YORK, NY	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	3,315	2,902	1.14	6,785	51,672	58,457
162 PHOENIX, AZ	83 CHICAGO, IL	1,818	1,810	1.00	6,676	4,920	11,596
139 WICHITA, KS	180 LOS ANGELES, CA	1,569	1,495	1.05	6,563	7,368	13,931
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	125 DALLAS-FORT WORTH, TX	1,939	1,791	1.08	5,909	16,032	21,941
165 SALT LAKE CITY-OGDEN, UT	83 CHICAGO, IL	1,485	1,405	1.06	5,907	0	5,907
83 CHICAGO, IL	168 SPOKANE, WA	1,842	1,806	1.02	5,600	0	5,600
83 CHICAGO, IL	164 RENO, NV	1,982	1,904	1.04	5,434	28,524	33,958
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	113 NEW ORLEANS, LA	2,420	2,266	1.07	5,227	7,692	12,919
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	165 SALT LAKE CITY-OGDEN, UT	807	719	1.12	4,993	0	4,993
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	12 NEW YORK, NY	3,315	2,902	1.14	4,970	12,348	17,318
172 PORTLAND, OR	162 PHOENIX, AZ	1,421	1,308	1.09	4,847	8,904	13,751
96 MINNEAPOLIS-ST. PAUL, MN	172 PORTLAND, OR	1,770	1,733	1.02	4,758	0	4,758
172 PORTLAND, OR	179 FRESNO-BAKERSFIELD, CA	817	754	1.08	4,653	4,140	8,793
125 DALLAS-FORT WORTH, TX	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,939	1,791	1.08	4,612	35,688	40,300
173 EUGENE, OR	162 PHOENIX, AZ	1,351	1,202	1.12	4,585	0	4,585

Table 22

DOUBLE STACK RAIL NETWORK DEFINED BY RAIL HAUL OF AT LEAST 725 MILES WHOLLY WITHIN CORRIDORS DEFINED BY ANNUAL FEU VOLUME OF 60 PERCENT OF 46,800
AND ANNUAL FEU VOLUME OF AT LEAST 60 PERCENT OF 2,600
WITH DIVERTED FEU VOLUMES FROM TRAM DATA
SORTED BY DESCENDING ANNUAL FEUS
DATA SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE AND ANNUALIZED TRAM TRUCK VOLUMES

ORIGIN BEA NUMBER AND NAME	DESTINATION BEA NUMBER AND NAME	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO	RAIL FEUS	TRAM FEUS	TOTAL FEUS
173 EUGENE, OR	83 CHICAGO, IL	2,319	2,236	1.04	4,498	0	4,498
105 KANSAS CITY, MO	162 PHOENIX, AZ	1,359	1,362	1.00	4,482	0	4,482
71 DETROIT, MI	162 PHOENIX, AZ	2,071	2,060	1.01	4,422	0	4,422
173 EUGENE, OR	12 NEW YORK, NY	3,245	3,018	1.08	4,418	0	4,418
135 AMARILLO, TX	180 LOS ANGELES, CA	1,219	1,078	1.13	4,257	7,692	11,949
172 PORTLAND, OR	96 MINNEAPOLIS-ST. PAUL, MN	1,777	1,733	1.03	4,047	0	4,047
178 STOCKTON-MODESTO, CA	9 ROCHESTER, NY	2,909	2,666	1.09	3,765	0	3,765
178 STOCKTON-MODESTO, CA	125 DALLAS-FORT WORTH, TX	1,861	1,757	1.06	3,746	40,080	43,826
170 YAKIMA, WA	83 CHICAGO, IL	2,074	2,003	1.04	3,653	0	3,653
178 STOCKTON-MODESTO, CA	12 NEW YORK, NY	3,223	2,869	1.12	3,582	0	3,582
179 FRESNO-BAKERSFIELD, CA	113 NEW ORLEANS, LA	2,161	2,113	1.02	3,536	0	3,536
111 LITTLE ROCK-N. LITTLE ROCK, AR	180 LOS ANGELES, CA	2,102	1,675	1.25	3,419	4,920	8,339
71 DETROIT, MI	171 SEATTLE, WA	2,493	2,360	1.06	3,333	0	3,333
96 MINNEAPOLIS-ST. PAUL, MN	18 PHILADELPHIA, PA	1,253	1,199	1.05	3,246	0	3,246
178 STOCKTON-MODESTO, CA	122 HOUSTON, TX	1,984	1,883	1.05	3,218	20,952	24,170
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	162 PHOENIX, AZ	800	713	1.12	3,064	4,920	7,984
172 PORTLAND, OR	4 BOSTON, MA	3,222	3,081	1.05	3,060	0	3,060
171 SEATTLE, WA	18 PHILADELPHIA, PA	3,003	2,862	1.05	3,039	0	3,039
154 MISSOULA, MT	96 MINNEAPOLIS-ST. PAUL, MN	1,225	1,188	1.03	3,037	0	3,037
83 CHICAGO, IL	7 ALBANY-SCHENECTADY-TROY, NY	817	826	0.99	3,025	0	3,025
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	18 PHILADELPHIA, PA	3,247	2,886	1.13	3,019	4,920	7,939
83 CHICAGO, IL	160 ALBUQUERQUE, NM	1,383	1,344	1.03	2,977	0	2,977
83 CHICAGO, IL	177 SACRAMENTO, CA	2,137	2,040	1.05	2,960	0	2,960
180 LOS ANGELES, CA	133 EL PASO, TX	813	802	1.01	2,751	4,920	7,671
178 STOCKTON-MODESTO, CA	17 HARRISBURG-YORK-LANCASTER, PA	3,048	2,752	1.11	2,685	0	2,685
177 SACRAMENTO, CA	125 DALLAS-FORT WORTH, TX	2,145	1,802	1.19	2,648	0	2,648
19 BALTIMORE, MD	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	3,033	2,830	1.07	2,595	0	2,595
171 SEATTLE, WA	71 DETROIT, MI	2,493	2,360	1.06	2,575	0	2,575
173 EUGENE, OR	6 HARTFORD-NEW HAVEN-SPRINGFLD, CT-MA	3,285	3,134	1.05	2,560	0	2,560
180 LOS ANGELES, CA	160 ALBUQUERQUE, NM	893	796	1.12	2,530	38,136	40,666
154 MISSOULA, MT	180 LOS ANGELES, CA	1,330	1,243	1.07	2,520	0	2,520
187 UNKNOWN	125 DALLAS-FORT WORTH, TX	1,483	1,438	1.03	2,488	0	2,488
187 UNKNOWN	180 LOS ANGELES, CA	2,734	2,522	1.08	2,472	0	2,472
96 MINNEAPOLIS-ST. PAUL, MN	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,100	2,016	1.04	2,428	0	2,428
172 PORTLAND, OR	122 HOUSTON, TX	2,683	2,365	1.13	2,395	0	2,395
133 EL PASO, TX	83 CHICAGO, IL	1,386	1,601	0.87	2,368	0	2,368
187 UNKNOWN	105 KANSAS CITY, MO	946	999	0.95	2,348	0	2,348
141 TOPEKA, KS	180 LOS ANGELES, CA	1,673	1,555	1.08	2,330	0	2,330
178 STOCKTON-MODESTO, CA	70 TOLEDO, OH	2,552	2,302	1.11	2,290	0	2,290
187 UNKNOWN	107 ST. LOUIS, MO	734	768	0.96	2,215	0	2,215
169 RICHLAND, WA	88 ROCKFORD, IL	1,934	1,868	1.04	2,209	0	2,209
180 LOS ANGELES, CA	111 LITTLE ROCK-N. LITTLE ROCK, AR	2,102	1,675	1.25	2,190	20,952	23,142
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	55 MEMPHIS, TN	2,404	2,081	1.16	2,188	0	2,188
173 EUGENE, OR	4 BOSTON, MA	3,347	3,195	1.05	2,107	0	2,107
168 SPOKANE, WA	83 CHICAGO, IL	1,842	1,806	1.02	2,105	0	2,105
70 TOLEDO, OH	4 BOSTON, MA	781	768	1.02	2,067	0	2,067
71 DETROIT, MI	172 PORTLAND, OR	2,511	2,373	1.06	1,993	0	1,993

Table 22

DOUBLE STACK RAIL NETWORK DEFINED BY RAIL HAUL OF AT LEAST 725 MILES WHOLLY WITHIN CORRIDORS DEFINED BY ANNUAL FEU VOLUME OF 60 PERCENT OF 46,800
AND ANNUAL FEU VOLUME OF AT LEAST 60 PERCENT OF 2,600
WITH DIVERTED FEU VOLUMES FROM TRAM DATA
SORTED BY DESCENDING ANNUAL FEUS
DATA SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE AND ANNUALIZED TRAM TRUCK VOLUMES

ORIGIN BEA NUMBER AND NAME	DESTINATION BEA NUMBER AND NAME	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO	RAIL FEUS	TRAM FEUS	TOTAL FEUS
173 EUGENE, OR	18 PHILADELPHIA, PA	3,177	3,002	1.06	1,982	0	1,982
187 UNKNOWN	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,907	2,602	1.12	1,977	0	1,977
139 WICHITA, KS	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,869	1,751	1.07	1,960	0	1,960
178 STOCKTON-MODESTO, CA	55 MEMPHIS, TN	2,326	2,045	1.14	1,956	0	1,956
173 EUGENE, OR	20 WASHINGTON, DC	3,121	2,941	1.06	1,872	0	1,872
12 NEW YORK, NY	171 SEATTLE, WA	3,071	2,892	1.06	1,870	8,088	9,958
12 NEW YORK, NY	105 KANSAS CITY, MO	1,333	1,171	1.14	1,870	0	1,870
135 AMARILLO, TX	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,520	1,356	1.12	1,852	0	1,852
160 ALBUQUERQUE, NM	83 CHICAGO, IL	1,383	1,344	1.03	1,840	0	1,840
154 MISSOULA, MT	83 CHICAGO, IL	1,663	1,605	1.04	1,787	0	1,787
164 RENO, NV	83 CHICAGO, IL	1,982	1,904	1.04	1,760	0	1,760
178 STOCKTON-MODESTO, CA	4 BOSTON, MA	3,325	3,046	1.09	1,754	7,692	9,446
122 HOUSTON, TX	133 EL PASO, TX	817	762	1.07	1,745	0	1,745
71 DETROIT, MI	135 AMARILLO, TX	1,270	1,312	0.97	1,742	0	1,742
169 RICHLAND, WA	180 LOS ANGELES, CA	1,198	1,179	1.02	1,738	4,140	5,878
12 NEW YORK, NY	96 MINNEAPOLIS-ST. PAUL, MN	1,321	1,228	1.08	1,725	0	1,725
178 STOCKTON-MODESTO, CA	18 PHILADELPHIA, PA	3,155	2,853	1.11	1,720	8,088	9,808
105 KANSAS CITY, MO	160 ALBUQUERQUE, NM	931	896	1.04	1,688	0	1,688
178 STOCKTON-MODESTO, CA	113 NEW ORLEANS, LA	2,344	2,232	1.05	1,662	0	1,662
178 STOCKTON-MODESTO, CA	143 OMAHA, NE	1,730	1,604	1.08	1,660	8,088	9,748
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	88 ROCKFORD, IL	2,217	2,055	1.08	1,655	0	1,655
143 OMAHA, NE	176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,787	1,637	1.09	1,605	8,088	9,693
105 KANSAS CITY, MO	65 CLEVELAND, OH	748	782	0.96	1,598	0	1,598

Table 22

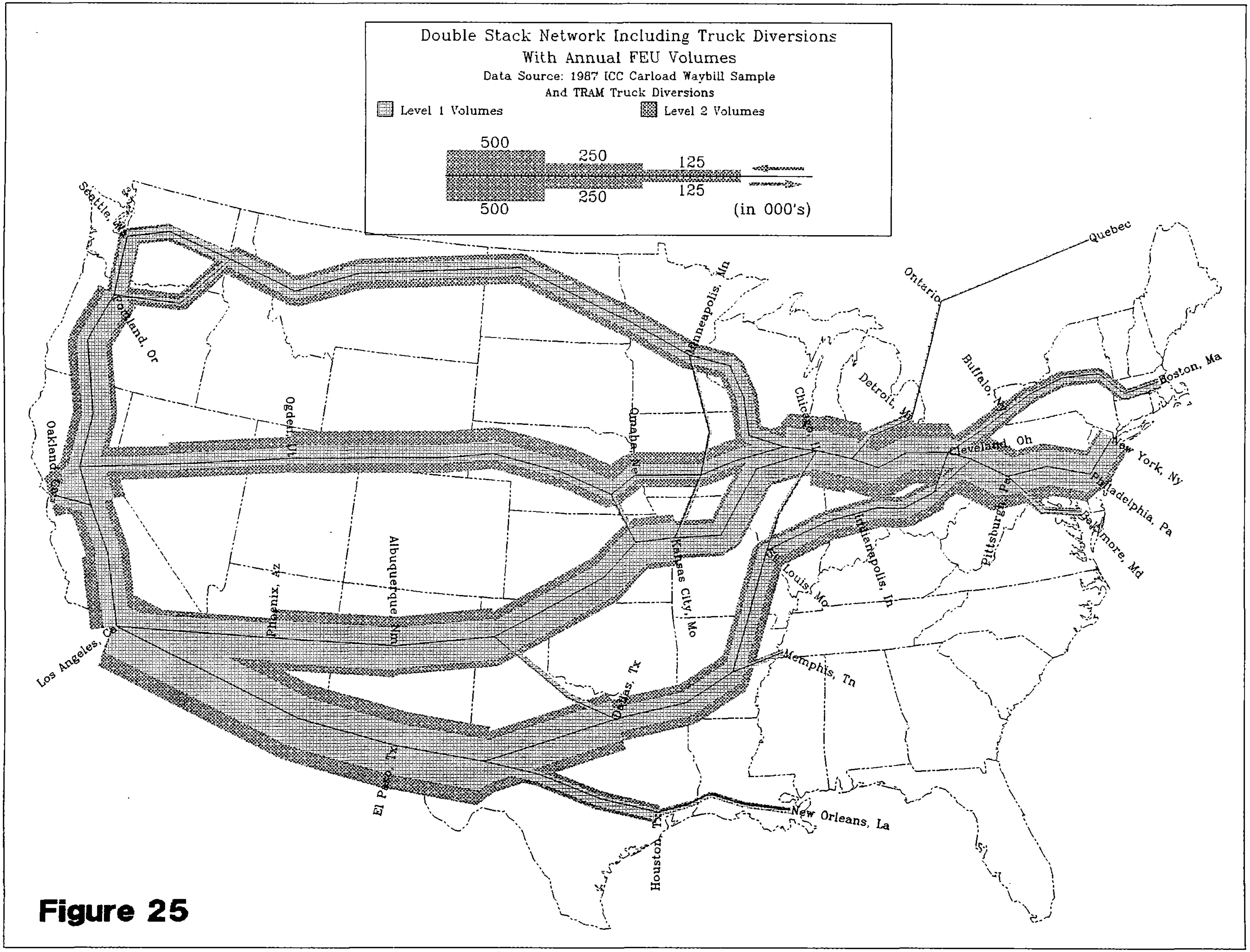

Double Stack Network Including Truck Diversions
With Annual FEU Volumes
Data Source: 1987 ICC Carload Waybill Sample
And TRAM Truck Diversions
Level 1 Volumes
Level 2 Volumes
500
250
125
125
250
500
(in 000's)
Seattle, Wa
Portland, Or
Oakland, Ca
Los Angeles, Ca
Ogden, Ut
Phoenix, Az
Albuquerque, Nm
El Paso, Tx
Minneapolis, Mn
Omaha, Ne
Kansas City, Mo
Dallas, Tx
Houston, Tx
Chicago, Il
St. Louis, Mo
Memphis, Tn
New Orleans, La
Detroit, Mi
Indianapolis, In
Ontario
Quebec
Buffalo, Ny
Cleveland, Oh
Pittsburgh, Pa
Boston, Ma
New York, Ny
Philadelphia, Pa
Baltimore, Md

Figure 25

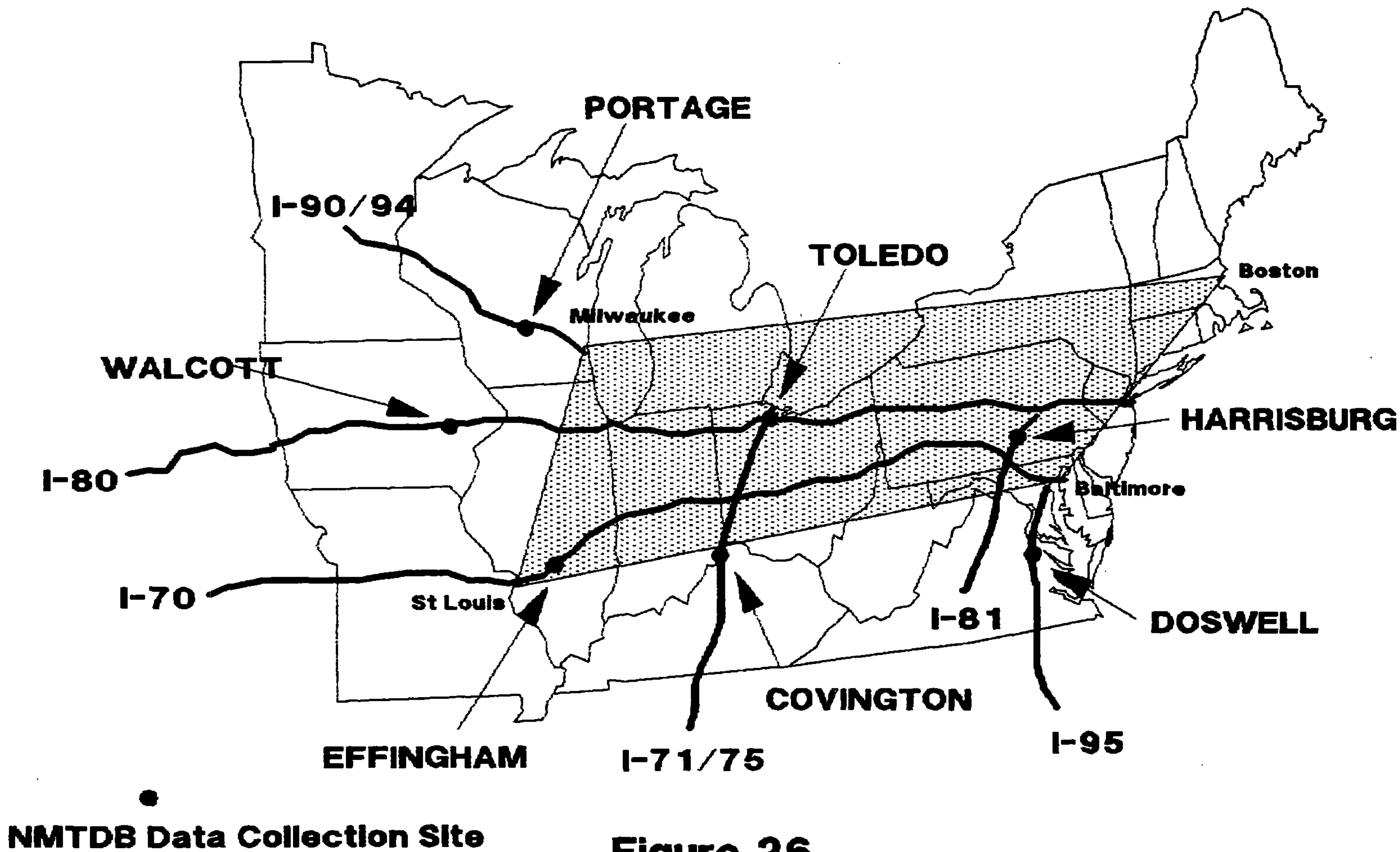


Figure 26

NORTHEAST TRUCK ROUTES

of this area via major Interstate highways. As Figure 26 shows, NMTDB data collection points are at Portage, WI (I-90, I-94); Walcot, IA (I-80); Effingham, IL (I-70); Covington, KY (I-75 I-71); Harrisburg, PA (I-81); and Doswell, VA (I-95). The only collection point within this critical industrial rectangle is near Toledo, on I-90/I-94. Exhaustive examination of multi-year NMTDB data for this point yielded insufficient data for reliable statistical inference on flows within the Northeast.

There appear to be two principal reasons for this lack of truck data. First, there are multiple highway routes in the Northeast. Second, information from industry contacts suggests that pavement and bridge deterioration and traffic congestion on significant portions of Interstate 80 has led truckers to prefer other routes, specifically Interstate 70.

3. Corroborative Results

Confidence in these findings is increased, despite the limitations of the available data, because they correspond closely to the findings of other studies and analyses covering state and U.S. highways as well as Interstates.

- AAR Study. In a multi-year analysis of NMTDB data, the AAR found that truckload highway traffic had grown only slightly in major double-stack corridors while it had grown strongly overall. (Intermodal Trends, Volume I, Number 8, AAR Intermodal Policy Division, April 14, 1989)

- Trailer Train Transloading Study. A survey by Trailer Train showed that double-stack loadings in Southern California had outpaced import growth. Upon investigation, Trailer Train found that the former practice of transloading containerized imports into highway trailers for movement east had declined sharply in favor of through rail movement of import containers. (Intermodal Market Survey, Trailer Train Company, 1989)

- ATLF Regional Emphasis. J.B. Hunt Transport, Schneider National, and other Advanced Truckload Firms have reduced their activity in major double-stack corridors, emphasizing regional trucking markets instead. (Industry publications)

- o Agricultural Truck Rate Shifts. USDA data on refrigerated truck rates shows that in 1988, long-haul truck rates for California growing regions within drayage reach of Los Angeles were depressed relative to other California truck rates, and that regional rates to Denver were likewise depressed. This rate shift suggests an underlying shift of truckload carriers out of the double-stack corridors and into refrigerated and regional trucking, depressing rates in those corridors. (Fruit and Vegetable Rate and Cost Summary, Office of Transportation, USDA, 1987 and 1988.)

Each of these studies suggests a similar conclusion: rail intermodal service, specifically double-stacks, has diverted a significant amount of truckload traffic in the most susceptible markets, and motor carriers have shifted some of their activity to less-susceptible markets. It is also reasonable to conclude that double-stack services will divert additional truckload traffic in the most susceptible markets.

D. NETWORK OVERVIEW

The network described in the preceding tables and figures includes corridors where, according to the service and cost criteria derived herein and the traffic data available from 1987, double-stack services could be fully competitive with truckload service. It should come as no surprise that this network includes the long-distance, high-volume double-stack services now operating, and most of the high-volume trailer flows. This network, however, is focused on the ability to attract domestic truck traffic. Accordingly, it does not include some existing double-stack movements of domestic or international containers, especially those that developed between 1987 and 1990.

The flows developed here could be described as a "core network" of services able to hold their own in direct competition with truckload carriers. Of course, there is no guarantee that every corridor that matches the general criteria will be a commercial success. The service and cost criteria both embody assumptions about double-stack operations that are not yet consistently met in day-to-day operations.

The inclusion of intermediate points anticipates a maturation of the network, and an integration of double-stack services into overall rail operations, that is now just beginning. The train system that American President Intermodal superimposes on the railroads offers service to and from some intermediate points such as Salt Lake City and Fresno. The presence of major customers has also led to double-stack service to Modesto, California, Newton, Iowa, and Marysville, Ohio. Much of the traffic generated at intermediate points is still carried in boxcars, and presents a real challenge to marketers of domestic container service.

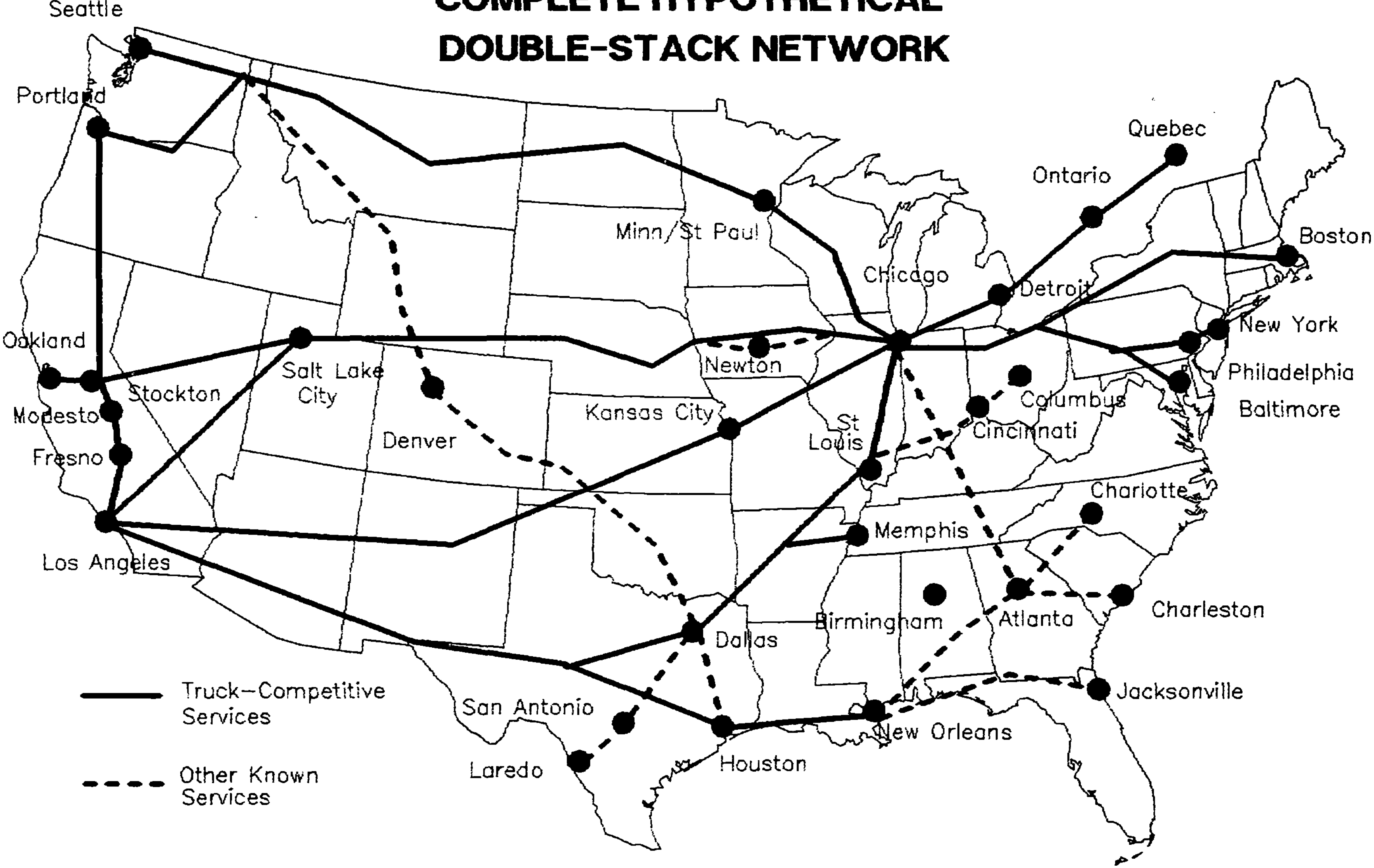
The data processing performed for this study did not distinguish among different railroads or routes serving the same endpoints. Yet service to some intermediate points depends on through service to major hubs on the same railroad: if the railroad in question does not offer fully competitive service to the major hubs, service to intermediate points may not develop.

Counterbalancing this uncertainly is the possibility that creative operations planners could combine end-to-end flows to create higher service frequencies at midpoints. Moreover, by combining traffic to and from several sources, railroad operations planners may be able to justify frequent domestic double-stack services that are not identifiable from the Carload Waybill Sample alone.

Figure 27 combines the network shown in Figure 25 with the additional double-stack services being offered in late 1989 (shown on Figure 11) to display a more complete hypothetical double-stack network. This more complete network thus includes routes that will or already have double-stack service because:

- o double-stack service can be fully truck-competitive (the core network);

Figure 27
COMPLETE HYPOTHETICAL DOUBLE-STACK NETWORK



Note: Lines indicate service corridors, not specific railroad routes

- o double-stack service is being provided for international flows, or
- o double-stack service is being provided under contract for specific domestic shippers, regardless of its ability to compete for common carriage.

E. HYPOTHETICAL 2000 DOUBLE-STACK NETWORK

1. Forecasts

As this study progressed, it became clear that the 1987 data above were not sufficient to determine:

- o whether domestic double-stack service would spread throughout the rail network;
- o whether existing and planned terminal capacity would be able to accommodate growth; or
- o what additional equipment would be required.

Accordingly, available intermodal forecasts were used to determine, very roughly, what a domestic and international double-stack network might look like in 2000.

Several projections for near-term overall intermodal growth have been published:

- o Data Resources, Inc.:
  4 percent average annual growth 1988 - 1993
- o Economic Consulting and Planning, Inc:
  +3 percent 1989 - 1990
  -2.5 percent 1990 - 1991
- o Richard Telofski, Consultant:
  +4.6 percent 1989 - 1990

- Trailer Train:
  2 - 4 percent annual growth through early 1990's

An average 4 percent annual growth through 1995 appears to be in reasonable agreement with the above selection of announced projections. As of September, 1989, intermodal traffic was running about 3 percent ahead of 1988.

Growth of international container traffic will continue to increase double-stack container flows. The introduction of double-stack service coincided with a period of strong growth in international container cargo flows, particularly in imports. According to DRI world trade data, tonnage of containerizable imports grew at an average of 11.2 percent annually between 1983 and 1987; exports grew at an average of 6.3 percent. According to DRI's forecasts, containerizable liner import tonnage is expected to grow by an average of 3.7 percent annually between 1988 and 1992, and the 1991-1992 growth is expected to be 5.1 percent. Export tonnage is expected to grow faster, at an average annual rate of 7.3 percent between 1988 and 1992, with 5.8 percent annual grow in 1991 - 1992. Extrapolating these forecasts for the period 1987 - 1995 (using the 1991-1992 forecast growth rates for 1992 - 1995) yields overall annual average growth rates of 3.8 percent for containerizable liner import tonnage and 7.5 percent for containerizable liner export tonnage. In applying DRI's growth rates to estimated 1987 international rail container movements, it is implicitly assumed that:

- Average annual growth between 1992 and 1995 will be at the same rates as the forecast growth of imports and exports between 1991 and 1992;

- These same growth rates will apply to all U.S. international containerizable trade on all four coasts; and

- Estimated import and export international container flows moving by rail will grow at the same rate as total U.S. import and export containerizable liner tonnage.

2. Year 2000 Network with 4 Percent Growth

Under an assumption of uniform 4 percent annual intermodal growth, the hypothetical 1987 network described earlier would expand into a number of additional major corridors. Table 23 lists twelve major corridors for the year 2000, in addition to those listed for 1987. The additional corridors, shown in Figure 28, fall into four groups:

- new corridors between Chicago and Hartford, Norfolk, Houston, Denver, and Stockton;

- new corridors between Los Angeles and Portland, Eugene, St. Louis, and Atlanta;

- a new corridor between San Francisco-Oakland and Houston; and

- two new corridors radiating east from St. Louis to Philadelphia and New York.

In other words, traffic growth would support two new major hubs, San Francisco-Oakland and St. Louis, by the year 2000.

Care must be taken in interpreting these findings, especially with regard to containerizable flows that are largely boxcar traffic at present. Eugene, Oregon is a case in point. A potential Eugene-Los Angeles double-stack corridor is shown in Table 23 for the year 2000, yet as of 1990 there is no direct intermodal service to Eugene, and no intermodal yard there. The emergence of a Eugene-Los Angeles double-stack corridor depends almost entirely on the conversion of boxcar traffic, in this case primarily lumber and paper products.

Table 24 lists the intermediate points that could be served by the uniform-growth year 2000 network. The list expands two ways: by the traffic increase on major 1987 corridors, and by the addition of intermediate points on new corridors. Figure 29 illustrates this expansion.

RAIL TRAFFIC MEETING ANNUAL VOLUME CRITERIA OF 60 PERCENT OF 46,800 ANNUAL FEUS IN 2000
AND AT LEAST 725 MILES OF RAIL DISTANCE
BY ORIGIN BEA AND DESTINATION BEA WITH RAIL-HIGHWAY CIRCUITY APPENDED
SORTED BY ANNUAL FEUS
SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE WITH ASSUMED 4 PERCENT ANNUAL GROWTH TO YEAR 2000

ORIGIN BEA NUMBER	AND NAME	DESTINATION BEA NUMBER	AND NAME	ANNUAL FEUS	ANNUAL NET TONS	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO
180	LOS ANGELES, CA	83	CHICAGO, IL	311,459	4,443,940	2,199	2,040	1.08
83	CHICAGO, IL	180	LOS ANGELES, CA	267,039	3,799,308	2,199	2,040	1.08
83	CHICAGO, IL	12	NEW YORK, NY	264,822	4,271,018	904	815	1.11
12	NEW YORK, NY	83	CHICAGO, IL	240,761	1,693,473	904	815	1.11
171	SEATTLE, WA	83	CHICAGO, IL	189,407	2,885,789	2,166	2,080	1.04
83	CHICAGO, IL	171	SEATTLE, WA	171,767	1,527,325	2,166	2,080	1.04
83	CHICAGO, IL	18	PHILADELPHIA, PA	132,472	2,226,063	836	785	1.06
83	CHICAGO, IL	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	98,880	1,331,972	2,222	2,120	1.05
83	CHICAGO, IL	4	BOSTON, MA	93,610	1,570,950	1,006	992	1.01
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	83	CHICAGO, IL	88,639	1,530,013	2,222	2,120	1.05
83	CHICAGO, IL	19	BALTIMORE, MD	81,855	1,308,888	811	773	1.05
122	HOUSTON, TX	180	LOS ANGELES, CA	76,257	1,449,826	1,630	1,564	1.04
83	CHICAGO, IL	125	DALLAS-FORT WORTH, TX	74,955	1,146,869	992	965	1.03
186	QUEBEC	83	CHICAGO, IL	66,969	1,166,184	835	851	0.98
4	BOSTON, MA	83	CHICAGO, IL	62,772	667,428	1,006	992	1.01
83	CHICAGO, IL	172	PORTLAND, OR	62,339	752,613	2,193	2,122	1.03
179	FRESNO-BAKERSFIELD, CA	83	CHICAGO, IL	61,786	1,289,013	2,301	2,154	1.07
180	LOS ANGELES, CA	55	MEMPHIS, TN	58,219	835,417	2,104	1,803	1.17
18	PHILADELPHIA, PA	83	CHICAGO, IL	57,955	781,252	836	785	1.06
172	PORTLAND, OR	83	CHICAGO, IL	57,167	1,190,761	2,194	2,122	1.03
180	LOS ANGELES, CA	122	HOUSTON, TX	57,152	930,430	1,630	1,564	1.04
172	PORTLAND, OR	180	LOS ANGELES, CA	53,932	1,223,230	1,091	960	1.14
19	BALTIMORE, MD	83	CHICAGO, IL	53,527	729,602	811	773	1.05
180	LOS ANGELES, CA	125	DALLAS-FORT WORTH, TX	52,871	778,409	1,639	1,438	1.14
180	LOS ANGELES, CA	105	KANSAS CITY, MO	49,649	779,920	1,739	1,618	1.07
105	KANSAS CITY, MO	180	LOS ANGELES, CA	49,618	821,927	1,739	1,618	1.07
180	LOS ANGELES, CA	113	NEW ORLEANS, LA	48,221	802,912	1,990	1,913	1.04
55	MEMPHIS, TN	180	LOS ANGELES, CA	45,854	695,661	2,104	1,803	1.17
173	EUGENE, OR	180	LOS ANGELES, CA	45,575	1,092,821	966	854	1.13
180	LOS ANGELES, CA	12	NEW YORK, NY	43,264	582,223	3,106	2,789	1.11
83	CHICAGO, IL	17	HARRISBURG-YORK-LANCASTER, PA	41,129	706,457	729	681	1.07
107	ST. LOUIS, MO	12	NEW YORK, NY	38,423	674,901	1,058	939	1.13
83	CHICAGO, IL	157	DENVER, CO	36,092	532,131	1,020	1,023	1.00
122	HOUSTON, TX	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	34,252	589,822	2,060	1,917	1.07
180	LOS ANGELES, CA	107	ST. LOUIS, MO	32,066	529,330	2,041	1,854	1.10
178	STOCKTON-MODESTO, CA	83	CHICAGO, IL	31,665	714,130	2,182	2,087	1.05
107	ST. LOUIS, MO	180	LOS ANGELES, CA	31,045	502,333	2,041	1,854	1.10
180	LOS ANGELES, CA	36	ATLANTA, GA	30,581	471,822	2,478	2,224	1.11
113	NEW ORLEANS, LA	180	LOS ANGELES, CA	29,705	535,914	1,990	1,913	1.04
83	CHICAGO, IL	6	HARTFORD-NEW HAVEN-SPRINGFLD, CT-MA	28,649	481,613	944	931	1.01
107	ST. LOUIS, MO	18	PHILADELPHIA, PA	28,566	511,511	990	885	1.12
122	HOUSTON, TX	83	CHICAGO, IL	28,551	562,650	1,094	1,091	1.00
23	NORFOLK-VIRGINIA BCH-NEWPT NEWS, VA	83	CHICAGO, IL	28,539	498,390	1,050	956	1.10

Table 23

Double Stack Network For Year 2000

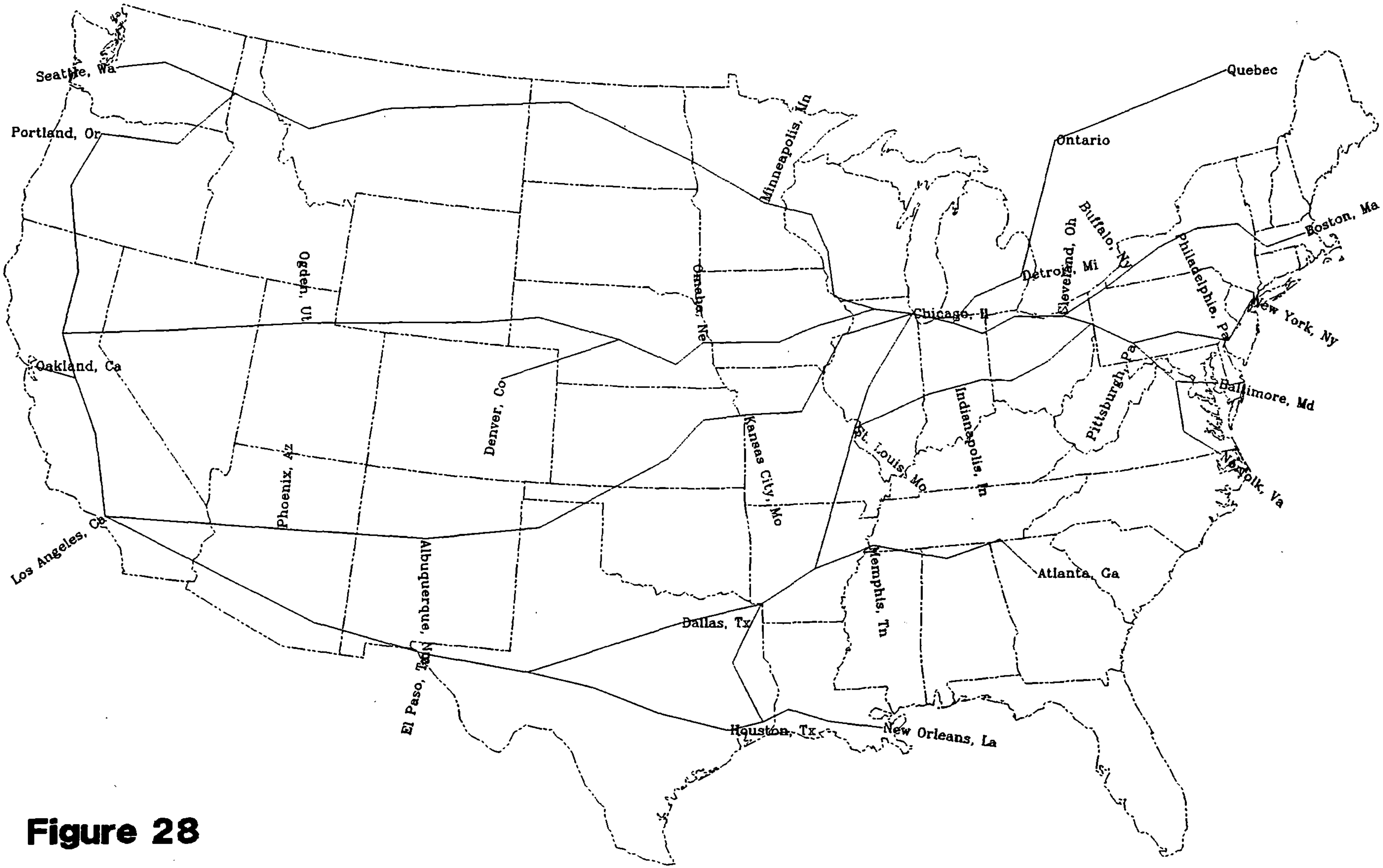


Figure 28

RAIL TRAFFIC TRAVELING ENTIRELY WITHIN CORRIDORS DEFINED BY 60 PERCENT OF ANNUAL FEUS IN 2000
AND WITH A RAIL DISTANCE OF AT LEAST 725 MILES
BY ORIGIN BEA AND DESTINATION BEA
SORTED BY DESCENDING ANNUAL FEUS
SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE WITH ASSUMED 4 PERCENT ANNUAL GROWTH TO YEAR 2000

ORIGIN BEA NUMBER	AND NAME	DESTINATION BEA NUMBER	AND NAME	ANNUAL FEUS	ANNUAL NET TONS	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO
36	ATLANTA, GA	180	LOS ANGELES, CA	27,154	459,960	2,478	2,224	1.11
125	DALLAS-FORT WORTH, TX	83	CHICAGO, IL	26,784	409,601	992	965	1.03
83	CHICAGO, IL	23	NORFOLK-VIRGINIA BCH-NEWPT NEWS, VA	26,083	378,045	1,050	956	1.10
83	CHICAGO, IL	165	SALT LAKE CITY-OGDEN, UT	23,199	318,795	1,485	1,405	1.06
83	CHICAGO, IL	122	HOUSTON, TX	21,296	301,718	1,067	1,091	0.98
12	NEW YORK, NY	180	LOS ANGELES, CA	20,752	268,943	3,106	2,789	1.11
171	SEATTLE, WA	12	NEW YORK, NY	20,352	277,701	3,071	2,892	1.06
83	CHICAGO, IL	162	PHOENIX AZ	20,077	247,683	1,818	1,810	1.00
180	LOS ANGELES, CA	172	PORTLAND, OR	19,400	291,481	1,091	960	1.14
71	DETROIT, MI	180	LOS ANGELES, CA	18,879	443,709	2,451	2,291	1.07
17	HARRISBURG-YORK-LANCASTER, PA	83	CHICAGO, IL	18,760	248,429	729	681	1.07
171	SEATTLE, WA	96	MINNEAPOLIS-ST. PAUL, MN	18,629	291,874	1,728	1,663	1.04
12	NEW YORK, NY	107	ST. LOUIS, MO	18,028	193,948	1,058	939	1.13
6	HARTFORD-NEW HAVEN-SPRINGFLD, CT-MA	83	CHICAGO, IL	17,497	179,961	944	931	1.01
122	HOUSTON, TX	107	ST. LOUIS, MO	17,117	342,672	828	852	0.97
113	NEW ORLEANS, LA	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	16,864	277,947	2,365	2,266	1.04
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	122	HOUSTON, TX	16,323	252,732	2,060	1,917	1.07
172	PORTLAND, OR	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	15,563	339,875	739	638	1.16
157	DENVER, CO	83	CHICAGO, IL	15,530	301,458	1,020	1,023	1.00
177	SACRAMENTO, CA	83	CHICAGO, IL	15,472	349,266	2,137	2,040	1.05
125	DALLAS-FORT WORTH, TX	180	LOS ANGELES, CA	14,981	234,695	1,639	1,438	1.14
169	RICHLAND, WA	83	CHICAGO, IL	14,798	342,705	1,996	1,945	1.03
107	ST. LOUIS, MO	19	BALTIMORE, MD	14,578	266,612	987	829	1.19
71	DETROIT, MI	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	14,315	338,676	2,561	2,371	1.08
83	CHICAGO, IL	179	FRESNO-BAKERSFIELD, CA	14,017	127,395	2,301	2,154	1.07
96	MINNEAPOLIS-ST. PAUL, MN	171	SEATTLE, WA	13,754	174,300	1,728	1,663	1.04
107	ST. LOUIS, MO	122	HOUSTON, TX	13,152	222,587	828	852	0.97
12	NEW YORK, NY	125	DALLAS-FORT WORTH, TX	13,109	184,856	1,777	1,524	1.17
71	DETROIT, MI	125	DALLAS-FORT WORTH, TX	12,951	299,347	1,246	1,209	1.03
55	MEMPHIS, TN	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	12,841	193,781	2,404	2,081	1.16
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	172	PORTLAND, OR	11,561	214,115	739	638	1.16
83	CHICAGO, IL	178	STOCKTON-MODESTO, CA	11,487	183,491	2,182	2,087	1.05
165	SALT LAKE CITY-OGDEN, UT	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	11,467	185,622	807	719	1.12
12	NEW YORK, NY	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	11,298	159,647	3,315	2,902	1.14
162	PHOENIX AZ	83	CHICAGO, IL	11,116	180,574	1,818	1,810	1.00
139	WICHITA, KS	180	LOS ANGELES, CA	10,928	214,821	1,569	1,495	1.05
107	ST. LOUIS, MO	17	HARRISBURG-YORK-LANCASTER, PA	10,348	186,755	883	784	1.13
18	PHILADELPHIA, PA	107	ST. LOUIS, MO	9,909	147,392	990	885	1.12
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	125	DALLAS-FORT WORTH, TX	9,839	176,484	1,939	1,791	1.08
165	SALT LAKE CITY-OGDEN, UT	83	CHICAGO, IL	9,836	175,582	1,485	1,405	1.06
180	LOS ANGELES, CA	66	COLUMBUS, OH	9,346	132,973	2,488	2,261	1.10
83	CHICAGO, IL	168	SPOKANE, WA	9,324	135,271	1,842	1,806	1.02
83	CHICAGO, IL	164	RENO, NV	9,048	118,620	1,982	1,904	1.04
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	113	NEW ORLEANS, LA	8,703	173,967	2,420	2,266	1.07
71	DETROIT, MI	122	HOUSTON, TX	8,588	205,803	1,330	1,391	0.96
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	165	SALT LAKE CITY-OGDEN, UT	8,314	165,908	807	719	1.12
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	12	NEW YORK, NY	8,275	158,901	3,315	2,902	1.14

Table 24

RAIL TRAFFIC TRAVELING ENTIRELY WITHIN CORRIDORS DEFINED BY 60 PERCENT OF ANNUAL FEUS IN 2000
AND WITH A RAIL DISTANCE OF AT LEAST 725 MILES
BY ORIGIN BEA AND DESTINATION BEA
SORTED BY DESCENDING ANNUAL FEUS
SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE WITH ASSUMED 4 PERCENT ANNUAL GROWTH TO YEAR 2000

ORIGIN BEA NUMBER AND NAME		DESTINATION BEA NUMBER AND NAME		ANNUAL FEUS	ANNUAL NET TONS	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO
172	PORTLAND, OR	162	PHOENIX AZ	8,071	180,894	1,421	1,308	1.09
96	MINNEAPOLIS-ST. PAUL, MN	172	PORTLAND, OR	7,922	110,894	1,770	1,733	1.02
172	PORTLAND, OR	179	FRESNO-BAKERSFIELD, CA	7,748	185,556	817	754	1.08
125	DALLAS-FORT WORTH, TX	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	7,679	125,993	1,939	1,791	1.08
173	EUGENE, OR	162	PHOENIX AZ	7,634	182,292	1,351	1,202	1.12
173	EUGENE, OR	83	CHICAGO, IL	7,490	178,596	2,319	2,236	1.04
105	KANSAS CITY, MO	162	PHOENIX AZ	7,463	123,282	1,359	1,362	1.00
71	DETROIT, MI	162	PHOENIX AZ	7,363	176,431	2,071	2,060	1.01
173	EUGENE, OR	12	NEW YORK, NY	7,356	176,531	3,245	3,018	1.08
135	AMARILLO, TX	180	LOS ANGELES, CA	7,088	142,264	1,219	1,078	1.13
172	PORTLAND, OR	96	MINNEAPOLIS-ST. PAUL, MN	6,739	136,636	1,777	1,733	1.03
121	BEAUMONT-PORT ARTHUR, TX	83	CHICAGO, IL	6,545	147,559	1,027	1,108	0.93
178	STOCKTON-MODESTO, CA	9	ROCHESTER, NY	6,269	150,456	2,909	2,666	1.09
178	STOCKTON-MODESTO, CA	125	DALLAS-FORT WORTH, TX	6,237	143,183	1,861	1,757	1.06
170	YAKIMA, WA	83	CHICAGO, IL	6,083	133,639	2,074	2,003	1.04
178	STOCKTON-MODESTO, CA	12	NEW YORK, NY	5,964	142,730	3,223	2,869	1.12
179	FRESNO-BAKERSFIELD, CA	113	NEW ORLEANS, LA	5,888	127,245	2,161	2,113	1.02
111	LITTLE ROCK-N. LITTLE ROCK, AR	180	LOS ANGELES, CA	5,693	107,524	2,102	1,675	1.25
71	DETROIT, MI	171	SEATTLE, WA	5,550	103,767	2,493	2,360	1.06
96	MINNEAPOLIS-ST. PAUL, MN	18	PHILADELPHIA, PA	5,405	125,347	1,253	1,199	1.05
178	STOCKTON-MODESTO, CA	122	HOUSTON, TX	5,358	123,515	1,984	1,883	1.05
18	PHILADELPHIA, PA	125	DALLAS-FORT WORTH, TX	5,202	93,444	1,709	1,456	1.17
66	COLUMBUS, OH	180	LOS ANGELES, CA	5,162	77,126	2,488	2,261	1.10
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	162	PHOENIX AZ	5,102	109,042	800	713	1.12
172	PORTLAND, OR	4	BOSTON, MA	5,095	120,318	3,222	3,081	1.05
19	BALTIMORE, MD	107	ST. LOUIS, MO	5,062	87,117	987	829	1.19
171	SEATTLE, WA	18	PHILADELPHIA, PA	5,060	110,561	3,003	2,862	1.05
154	MISSOULA, MT	96	MINNEAPOLIS-ST. PAUL, MN	5,057	121,217	1,225	1,188	1.03
83	CHICAGO, IL	7	ALBANY-SCHENECTADY-TROY, NY	5,037	96,241	817	826	0.99
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	18	PHILADELPHIA, PA	5,027	117,088	3,247	2,886	1.13
83	CHICAGO, IL	160	ALBUQUERQUE, NM	4,957	59,277	1,383	1,344	1.03
83	CHICAGO, IL	177	SACRAMENTO, CA	4,929	74,329	2,137	2,040	1.05
180	LOS ANGELES, CA	18	PHILADELPHIA, PA	4,681	96,361	3,038	2,734	1.11
180	LOS ANGELES, CA	133	ELPASO, TX	4,581	83,160	813	802	1.01
71	DETROIT, MI	157	DENVER, CO	4,541	108,696	1,315	1,274	1.03
178	STOCKTON-MODESTO, CA	17	HARRISBURG-YORK-LANCASTER, PA	4,471	107,297	3,048	2,752	1.11
177	SACRAMENTO, CA	125	DALLAS-FORT WORTH, TX	4,409	96,374	2,145	1,802	1.19
17	HARRISBURG-YORK-LANCASTER, PA	107	ST. LOUIS, MO	4,329	62,540	883	784	1.13
19	BALTIMORE, MD	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	4,321	66,137	3,033	2,830	1.07
83	CHICAGO, IL	120	TYLER-LONGVIEW, TX	4,321	54,814	921	928	0.99
171	SEATTLE, WA	71	DETROIT, MI	4,288	76,860	2,493	2,360	1.06
173	EUGENE, OR	6	HARTFORD-NEW HAVEN-SPRINGFLD, CT-MA	4,263	102,302	3,285	3,134	1.05
180	LOS ANGELES, CA	160	ALBUQUERQUE, NM	4,213	65,817	893	796	1.12
154	MISSOULA, MT	180	LOS ANGELES, CA	4,196	100,704	1,330	1,243	1.07
111	LITTLE ROCK-N. LITTLE ROCK, AR	12	NEW YORK, NY	4,188	99,838	1,385	1,209	1.15
187	ONTARIO	125	DALLAS-FORT WORTH, TX	4,143	98,239	1,483	1,438	1.03
187	ONTARIO	180	LOS ANGELES, CA	4,116	92,911	2,734	2,522	1.08

Table 24

RAIL TRAFFIC TRAVELING ENTIRELY WITHIN CORRIDORS DEFINED BY 60 PERCENT OF ANNUAL FEUS IN 2000
AND WITH A RAIL DISTANCE OF AT LEAST 725 MILES
BY ORIGIN BEA AND DESTINATION BEA
SORTED BY DESCENDING ANNUAL FEUS
SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE WITH ASSUMED 4 PERCENT ANNUAL GROWTH TO YEAR 2000

ORIGIN BEA NUMBER AND NAME		DESTINATION BEA NUMBER AND NAME		ANNUAL FEUS	ANNUAL NET TONS	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO
96	MINNEAPOLIS-ST. PAUL, MN	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	4,043	88,715	2,100	2,016	1.04
172	PORTLAND, OR	122	HOUSTON, TX	3,988	81,855	2,683	2,365	1.13
12	NEW YORK, NY	79	INDIANAPOLIS, IN	3,946	46,689	833	703	1.18
133	ELPASO, TX	83	CHICAGO, IL	3,943	67,336	1,386	1,601	0.87
187	ONTARIO	105	KANSAS CITY, MO	3,910	80,323	946	999	0.95
141	TOPEKA, KS	180	LOS ANGELES, CA	3,880	61,894	1,673	1,555	1.08
120	TYLER-LONGVIEW, TX	83	CHICAGO, IL	3,863	73,463	921	928	0.99
180	LOS ANGELES, CA	19	BALTIMORE, MD	3,826	60,009	3,035	2,678	1.13
178	STOCKTON-MODESTO, CA	70	TOLEDO, OH	3,813	91,512	2,552	2,302	1.11
125	DALLAS-FORT WORTH, TX	12	NEW YORK, NY	3,746	63,539	1,746	1,524	1.15
187	ONTARIO	107	ST. LOUIS, MO	3,688	69,667	734	768	0.96
169	RICHLAND, WA	88	ROCKFORD, IL	3,678	88,282	1,934	1,868	1.04
180	LOS ANGELES, CA	111	LITTLE ROCK-N. LITTLE ROCK, AR	3,647	45,939	2,102	1,675	1.25
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	55	MEMPHIS, TN	3,643	79,208	2,404	2,081	1.16
36	ATLANTA, GA	125	DALLAS-FORT WORTH, TX	3,563	88,882	950	785	1.21
173	EUGENE, OR	4	BOSTON, MA	3,508	83,986	3,347	3,195	1.05
168	SPOKANE, WA	83	CHICAGO, IL	3,505	66,270	1,842	1,806	1.02
51	CHATTANOOGA, TN	180	LOS ANGELES, CA	3,488	51,351	2,482	2,146	1.16
111	LITTLE ROCK-N. LITTLE ROCK, AR	18	PHILADELPHIA, PA	3,458	82,854	1,317	1,141	1.15
70	TOLEDO, OH	4	BOSTON, MA	3,442	57,079	781	768	1.02
179	FRESNO-BAKERSFIELD, CA	18	PHILADELPHIA, PA	3,430	78,658	3,147	2,848	1.10
18	PHILADELPHIA, PA	180	LOS ANGELES, CA	3,367	48,354	3,038	2,734	1.11
71	DETROIT, MI	172	PORTLAND, OR	3,318	72,464	2,511	2,373	1.06
173	EUGENE, OR	18	PHILADELPHIA, PA	3,300	79,058	3,177	3,002	1.06
187	ONTARIO	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	3,292	76,727	2,907	2,602	1.12
19	BALTIMORE, MD	180	LOS ANGELES, CA	3,272	75,794	3,035	2,678	1.13
139	WICHITA, KS	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	3,264	61,941	1,869	1,751	1.07
178	STOCKTON-MODESTO, CA	55	MEMPHIS, TN	3,257	75,028	2,326	2,045	1.14
179	FRESNO-BAKERSFIELD, CA	12	NEW YORK, NY	3,150	68,401	3,215	2,902	1.11
173	EUGENE, OR	20	WASHINGTON, DC	3,117	74,795	3,121	2,941	1.06
12	NEW YORK, NY	105	KANSAS CITY, MO	3,114	58,278	1,333	1,171	1.14
12	NEW YORK, NY	171	SEATTLE, WA	3,114	30,571	3,071	2,892	1.06
135	AMARILLO, TX	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	3,084	61,514	1,520	1,356	1.12
160	ALBUQUERQUE, NM	83	CHICAGO, IL	3,064	54,548	1,383	1,344	1.03
154	MISSOULA, MT	83	CHICAGO, IL	2,975	70,666	1,663	1,605	1.04
79	INDIANAPOLIS, IN	19	BALTIMORE, MD	2,931	34,367	762	593	1.28
164	RENO, NV	83	CHICAGO, IL	2,931	62,340	1,982	1,904	1.04
178	STOCKTON-MODESTO, CA	4	BOSTON, MA	2,921	69,667	3,325	3,046	1.09
65	CLEVELAND, OH	23	NORFOLK-VIRGINIA BCH-NEWPT NEWS, VA	2,917	44,691	788	560	1.41
122	HOUSTON, TX	133	ELPASO, TX	2,906	36,765	817	762	1.07
71	DETROIT, MI	135	AMARILLO, TX	2,901	69,600	1,270	1,312	0.97
169	RICHLAND, WA	180	LOS ANGELES, CA	2,894	69,067	1,198	1,179	1.02
12	NEW YORK, NY	96	MINNEAPOLIS-ST. PAUL, MN	2,872	50,119	1,321	1,228	1.08
121	BEAUMONT-PORT ARTHUR, TX	107	ST. LOUIS, MO	2,864	66,670	779	869	0.90
178	STOCKTON-MODESTO, CA	18	PHILADELPHIA, PA	2,864	68,734	3,155	2,853	1.11
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	36	ATLANTA, GA	2,851	58,278	2,798	2,576	1.09
105	KANSAS CITY, MO	160	ALBUQUERQUE, NM	2,811	46,822	931	896	1.04

Table 24

RAIL TRAFFIC TRAVELING ENTIRELY WITHIN CORRIDORS DEFINED BY 60 PERCENT OF ANNUAL FEUS IN 2000
AND WITH A RAIL DISTANCE OF AT LEAST 725 MILES
BY ORIGIN BEA AND DESTINATION BEA
SORTED BY DESCENDING ANNUAL FEUS
SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE WITH ASSUMED 4 PERCENT ANNUAL GROWTH TO YEAR 2000

ORIGIN BEA NUMBER AND NAME		DESTINATION BEA NUMBER AND NAME		ANNUAL FEUS	ANNUAL NET TONS	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO
178	STOCKTON-MODESTO, CA	113	NEW ORLEANS, LA	2,767	61,741	2,344	2,232	1.05
178	STOCKTON-MODESTO, CA	143	OMAHA, NE	2,764	53,682	1,730	1,604	1.08
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	88	ROCKFORD, IL	2,756	66,137	2,217	2,055	1.08
143	OMAHA, NE	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,672	55,081	1,787	1,637	1.09
17	HARRISBURG-YORK-LANCASTER, PA	125	DALLAS-FORT WORTH, TX	2,661	39,163	1,602	1,368	1.17
105	KANSAS CITY, MO	65	CLEVELAND, OH	2,661	56,946	748	782	0.96
111	LITTLE ROCK-N. LITTLE ROCK, AR	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,529	57,945	2,532	1,953	1.30
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	96	MINNEAPOLIS-ST. PAUL, MN	2,518	57,978	2,100	2,016	1.04
179	FRESNO-BAKERSFIELD, CA	122	HOUSTON, TX	2,489	51,551	1,865	1,764	1.06
121	BEAUMONT-PORT ARTHUR, TX	180	LOS ANGELES, CA	2,481	59,543	1,712	1,649	1.04
143	OMAHA, NE	165	SALT LAKE CITY-OGDEN, UT	2,481	50,871	1,024	922	1.11
187	ONTARIO	122	HOUSTON, TX	2,473	59,077	1,554	1,621	0.96
105	KANSAS CITY, MO	18	PHILADELPHIA, PA	2,414	56,013	1,265	1,116	1.13
4	BOSTON, MA	70	TOLEDO, OH	2,361	25,043	781	768	1.02
74	LANSING-KALAMAZOO, MI	180	LOS ANGELES, CA	2,356	56,546	2,450	2,226	1.10
74	LANSING-KALAMAZOO, MI	125	DALLAS-FORT WORTH, TX	2,331	55,946	1,213	1,144	1.06
7	ALBANY-SCHENECTADY-TROY, NY	83	CHICAGO, IL	2,304	36,132	817	826	0.99
12	NEW YORK, NY	162	PHOENIX AZ	2,303	48,354	2,725	2,463	1.11
111	LITTLE ROCK-N. LITTLE ROCK, AR	178	STOCKTON-MODESTO, CA	2,289	54,681	2,456	1,917	1.28
18	PHILADELPHIA, PA	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,281	42,226	3,117	2,886	1.08
133	ELPASO, TX	122	HOUSTON, TX	2,271	29,891	817	762	1.07
51	CHATTANOOGA, TN	125	DALLAS-FORT WORTH, TX	2,261	33,834	808	777	1.04
50	HUNTSVILLE-FLORENCE, AL	180	LOS ANGELES, CA	2,228	51,484	2,328	2,009	1.16
111	LITTLE ROCK-N. LITTLE ROCK, AR	74	LANSING-KALAMAZOO, MI	2,198	52,750	851	829	1.03
179	FRESNO-BAKERSFIELD, CA	55	MEMPHIS, TN	2,195	47,754	2,178	1,921	1.13
71	DETROIT, MI	165	SALT LAKE CITY-OGDEN, UT	2,170	52,050	1,781	1,656	1.08
173	EUGENE, OR	96	MINNEAPOLIS-ST. PAUL, MN	2,170	51,950	1,902	1,847	1.03
4	BOSTON, MA	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,156	27,773	3,417	3,079	1.11
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	4	BOSTON, MA	2,133	47,821	3,417	3,079	1.11
122	HOUSTON, TX	172	PORTLAND, OR	2,131	31,703	2,683	2,365	1.13
71	DETROIT, MI	143	OMAHA, NE	2,118	50,818	779	738	1.06
23	NORFOLK-VIRGINIA BCH-NEWPT NEWS, VA	96	MINNEAPOLIS-ST. PAUL, MN	2,110	34,301	1,467	1,369	1.07
65	CLEVELAND, OH	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,110	49,752	2,596	2,456	1.06
17	HARRISBURG-YORK-LANCASTER, PA	180	LOS ANGELES, CA	2,106	23,178	2,931	2,633	1.11
169	RICHLAND, WA	4	BOSTON, MA	2,088	47,821	3,002	2,942	1.02
83	CHICAGO, IL	133	ELPASO, TX	2,065	25,709	1,386	1,601	0.87
143	OMAHA, NE	178	STOCKTON-MODESTO, CA	2,065	39,962	1,747	1,604	1.09
65	CLEVELAND, OH	105	KANSAS CITY, MO	2,061	43,891	748	782	0.96
22	RICHMOND, VA	83	CHICAGO, IL	2,053	44,158	898	866	1.04
125	DALLAS-FORT WORTH, TX	161	TUCSON, AZ	2,053	39,829	1,243	952	1.31
133	ELPASO, TX	180	LOS ANGELES, CA	2,043	36,565	813	802	1.01
88	ROCKFORD, IL	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,003	48,087	2,217	2,055	1.08
162	PHOENIX AZ	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	2,001	32,935	800	713	1.12
36	ATLANTA, GA	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,998	48,487	2,958	2,576	1.15
83	CHICAGO, IL	169	RICHLAND, WA	1,943	18,516	1,996	1,945	1.03
133	ELPASO, TX	55	MEMPHIS, TN	1,940	41,294	1,155	1,085	1.06
105	KANSAS CITY, MO	64	YOUNGSTOWN-WARREN, OH	1,931	46,356	858	816	1.05

Table 24

RAIL TRAFFIC TRAVELING ENTIRELY WITHIN CORRIDORS DEFINED BY 60 PERCENT OF ANNUAL FEUS IN 2000
AND WITH A RAIL DISTANCE OF AT LEAST 725 MILES
BY ORIGIN BEA AND DESTINATION BEA
SORTED BY DESCENDING ANNUAL FEUS
SOURCE: 1987 ICC CARLOAD WAYBILL SAMPLE WITH ASSUMED 4 PERCENT ANNUAL GROWTH TO YEAR 2000

ORIGIN BEA NUMBER	AND NAME	DESTINATION BEA NUMBER	AND NAME	ANNUAL FEUS	ANNUAL NET TONS	RAIL DIST	HIWAY DIST	RAIL/ HIWAY RATIO
105	KANSAS CITY, MO	4	BOSTON, MA	1,910	45,556	1,418	1,417	1.00
105	KANSAS CITY, MO	10	BUFFALO, NY	1,878	40,428	931	966	0.96
179	FRESNO-BAKERSFIELD, CA	125	DALLAS-FORT WORTH, TX	1,878	41,960	1,735	1,638	1.06
119	TEXARKANA, TX	180	LOS ANGELES, CA	1,862	40,361	1,897	1,616	1.17
70	TOLEDO, OH	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,853	43,159	2,472	2,335	1.06
12	NEW YORK, NY	157	DENVER, CO	1,848	44,358	1,924	1,768	1.09
178	STOCKTON-MODESTO, CA	36	ATLANTA, GA	1,837	43,625	2,720	2,446	1.11
169	RICHLAND, WA	19	BALTIMORE, MD	1,830	43,425	2,806	2,693	1.04
172	PORTLAND, OR	12	NEW YORK, NY	1,825	41,860	3,120	2,904	1.07
116	LAKE CHARLES, LA	180	LOS ANGELES, CA	1,820	27,920	1,773	1,712	1.04
74	LANSING-KALAMAZOO, MI	176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	1,815	43,558	2,462	2,306	1.07
105	KANSAS CITY, MO	12	NEW YORK, NY	1,793	43,025	1,333	1,171	1.14
177	SACRAMENTO, CA	122	HOUSTON, TX	1,777	39,562	2,029	1,928	1.05
169	RICHLAND, WA	18	PHILADELPHIA, PA	1,763	41,360	2,832	2,749	1.03
176	SAN FRANCISCO-OAKLAND-SAN JOSE, CA	19	BALTIMORE, MD	1,760	36,898	3,222	2,830	1.14
177	SACRAMENTO, CA	113	NEW ORLEANS, LA	1,753	39,562	2,389	2,277	1.05
83	CHICAGO, IL	119	TEXARKANA, TX	1,732	27,507	777	793	0.98
107	ST. LOUIS, MO	133	ELPASO, TX	1,732	19,581	1,235	1,207	1.02
133	ELPASO, TX	107	ST. LOUIS, MO	1,732	31,237	1,235	1,207	1.02
179	FRESNO-BAKERSFIELD, CA	36	ATLANTA, GA	1,732	39,362	2,593	2,322	1.12
165	SALT LAKE CITY-OGDEN, UT	143	OMAHA, NE	1,728	36,232	1,024	922	1.11
83	CHICAGO, IL	22	RICHMOND, VA	1,695	37,298	898	866	1.04
99	DAVENPORT-ROCK ISLAND-MOLINE, IA-IL	17	HARRISBURG-YORK-LANCASTER, PA	1,690	40,561	922	851	1.08
23	NORFOLK-VIRGINIA BCH-NEWPT NEWS, VA	65	CLEVELAND, OH	1,677	26,974	788	560	1.41
18	PHILADELPHIA, PA	88	ROCKFORD, IL	1,652	39,629	924	871	1.06
165	SALT LAKE CITY-OGDEN, UT	88	ROCKFORD, IL	1,652	39,629	1,480	1,340	1.10
179	FRESNO-BAKERSFIELD, CA	105	KANSAS CITY, MO	1,652	34,334	1,874	1,732	1.08
55	MEMPHIS, TN	178	STOCKTON-MODESTO, CA	1,628	22,179	2,326	2,045	1.14
173	EUGENE, OR	113	NEW ORLEANS, LA	1,627	38,830	2,918	2,755	1.06
105	KANSAS CITY, MO	187	ONTARIO	1,623	31,636	960	999	0.96
172	PORTLAND, OR	113	NEW ORLEANS, LA	1,623	36,765	2,881	2,685	1.07
79	INDIANAPOLIS, IN	12	NEW YORK, NY	1,618	29,305	833	703	1.18
170	YAKIMA, WA	18	PHILADELPHIA, PA	1,608	38,163	2,910	2,806	1.04
178	STOCKTON-MODESTO, CA	165	SALT LAKE CITY-OGDEN, UT	1,605	35,066	768	686	1.12
18	PHILADELPHIA, PA	79	INDIANAPOLIS, IN	1,562	18,316	765	649	1.18
116	LAKE CHARLES, LA	83	CHICAGO, IL	1,562	36,299	967	1,045	0.93

Table 24

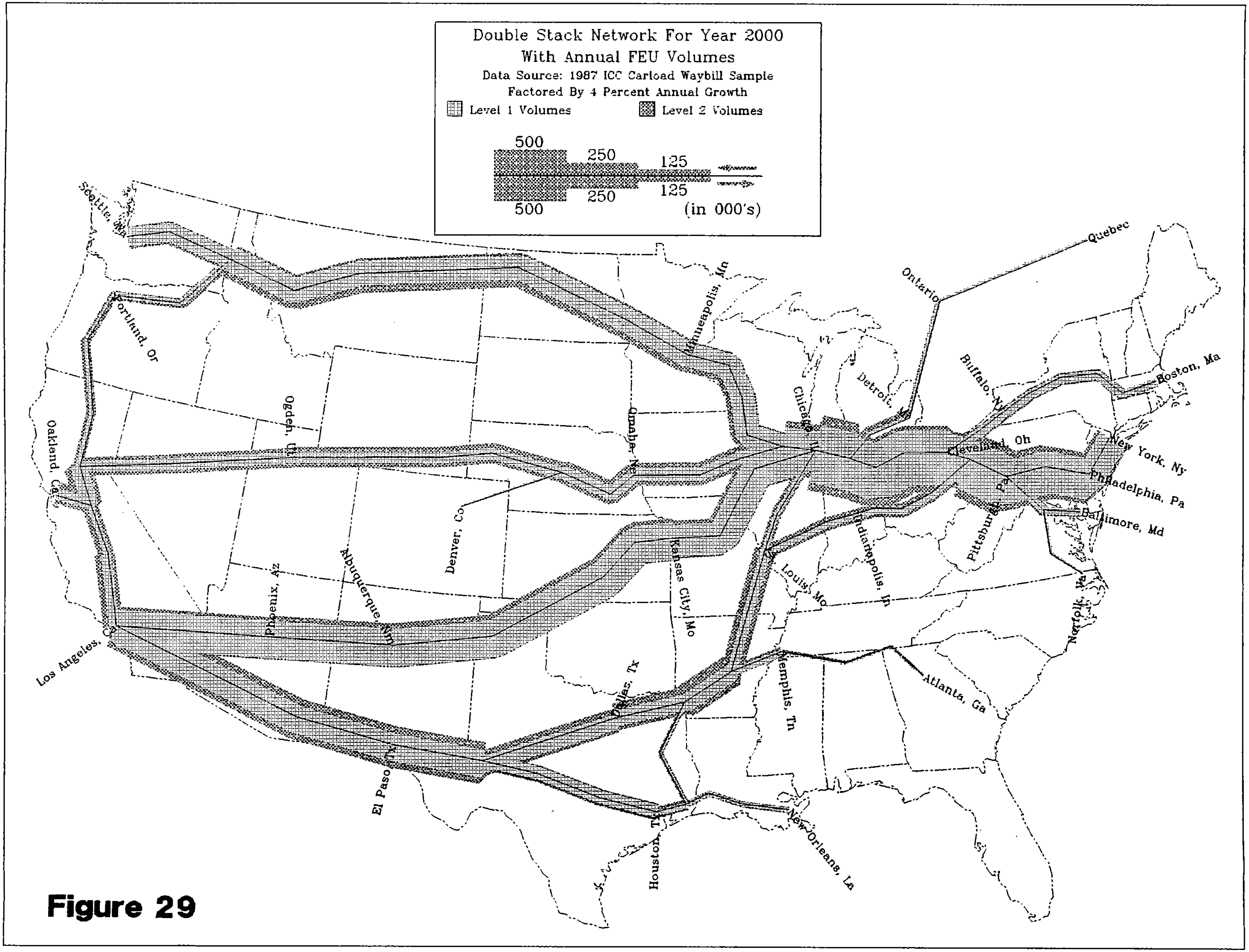

Double Stack Network For Year 2000
With Annual FEU Volumes
Data Source: 1987 ICC Carload Waybill Sample
Factored By 4 Percent Annual Growth
Level 1 Volumes
Level 2 Volumes
500
250
125
125
250
500
(in 000's)
Seattle, Wa
Portland, Or
Oakland, Ca
Los Angeles, Ca
Ogden, Ut
Phoenix, Az
Albuquerque, Nm
El Paso
Denver, Co
Minneapolis, Mn
Omaha, Ne
Kansas City, Mo
Dallas, Tx
Houston, Tx
New Orleans, La
Memphis, Tn
Chicago, Il
Louis, Mo
Indianapolis, In
Detroit, Mi
Ontario
Quebec
Buffalo, Ny
Cleveland, Oh
Pittsburgh, Pa
Boston, Ma
New York, Ny
Philadelphia, Pa
Baltimore, Md
Norfolk, Va
Atlanta, Ga

Figure 29

3. Major Trends and Data Adequacy

The purpose of this study task was to identify the broad pattern of domestic double-stack service development, and the scope of potential diversions from truckload carriers. The tables and figures incorporated in this section portray the potential truck-competitive network in considerable detail. Despite some shortcomings of the data that have been cited, the broad pattern of domestic double-stack development is apparent, and it is also apparent that there is great, although not unlimited scope for attraction of truckload traffic.

More complete and exact findings could be presented were better data available. The three primary data sources used in this study -- the ICC Carload Waybill Sample, the Bureau of the Census Import/Export data, and the National Motor Transport Database -- were designed before the advent of double-stack operations, and were not designed to be combined for this purpose. Any bias introduced by current data shortcomings is probably conservative: more flows would likely qualify for inclusion in the network if better data were available.

To the extent that detailed public or private planning for double-stack container transportation depends on such issues, the adequacy of publicly available data must be examined. For the purpose of understanding the major trends in double-stack service and domestic containerization, the data presented herein appear suuficient. With some few exceptions noted in the text, the criteria and network configurations developed herein correspond to the major development observable in the marketplace.

V. IMPLICATIONS FOR RAILROADS

A. VOLUME AND DIRECTIONAL BALANCE

1. Hypothetical 1987 Volumes

Table 25 lists the sources of double-stack traffic for the hypothetical 1987 truck-competitive network, and the remaining intermodal and non-intermodal flows. The figures show that the hypothetical truck-competitive double-stack network would include 52 percent of the containers and 37 percent of the trailers that moved by rail in 1987. Within the hypothetical truck-competitive network, domestic traffic accounts for most of the volume. Comparing the actual 1987 intermodal flows (Figure 11) with the double-stack core network in Figure 20, it is immediately apparent that not all the 1987 intermodal flows would qualify for inclusion in a fully truck-competitive network. This is not surprising, since existing piggyback services have made little impression on the truckers' market share in many corridors, and since many double-stack services are designed to serve the needs of ocean carriers rather than to compete with trucks.

Truck diversions could add substantially to the rail volumes on major corridors: nearly 0.5 million annual units of truck traffic are potentially divertible to the major corridors, and diverted truck traffic might support double-stack traffic on additional segments, bringing the total up to 3.8 million units. There are another 767,952 units of truck traffic potentially divertible at intermediate points.

If the hypothetical 1987 volumes are eventually realized, they will have grown further by the year 2000. These flows are summarized by source in Table 25.

2. Directional Balance

Directional balance could be an obstacle to achieving the large double-stack volumes discussed above. Consistent two-way loading and high utilization are required for double-stack services to realize their inherent

Table 25

1987 DOUBLE-STACK NETWORK TRAFFIC SOURCES

	Relevant 1987 Total	Major Corridors	Intermediate Points	Network Total	Other Intermodal	Non-Intermodal*
Containers	2,277,484	995,322	196,362	1,191,684	1,085,800	--
Trailers	2,972,591	763,290	345,374	1,108,664	1,863,927	--
Boxcars (Ctr Eqv)	3,107,496	187,269	220,292	407,561	--	2,699,935
Trucks	4,105,104	1,844,892	1,391,712	3,236,604	--	868,500
TOTAL	12,462,675	3,790,773	2,153,740	5,944,513	2,949,727	3,568,435

*Near-term conversion to double-stacked containers is not expected for this traffic.

Sources: Tables 34-42, Additional Data from ALK Associates line-haul cost advantages. The problem can be especially significant in attempting to divert traffic from trucks. Truckload common carriers usually move loaded in both directions, and attempt to minimize repositioning. The greater flexibility and market penetration of truckload carriers has left rail as the unbalanced mode. Because the total relevant traffic is typically unbalanced in any single corridor, railroads as a whole can become balanced double-stack operators only by forcing some other mode -- truck or rail piggyback -- to assume the imbalanced traffic. It is more likely that individual railroads and double-stack services will vary in the extent to which they achieve balanced flows.

Figure 30 illustrates the pattern of net imbalances implicit in the major 1987 double-stack network segments (southbound traffic is treated as westbound). It is apparent that some corridors would be seriously imbalanced were all the traffic shown actually carried. Some corridors, such as Los Angeles-Chicago and Seattle-Chicago, are imbalanced partly because of imbalanced international traffic. Others, such as Fresno-Chicago and Portland-Los Angeles, are imbalanced because they connect a highly populated consuming area with a much less populated producing area. The overall balance is reasonable -- the westbound flow is 86 percent of the eastbound -- but no railroad carries "overall" traffic.

Some limited triangulation could mitigate the imbalance. For example, the Seattle-Chicago flow has an eastbound imbalance and the Portland-chicago flow as a westbound imbalance, which suggests empty repositioning between Portland and Seattle. The Los Angeles-Chicago flow has an eastbound imbalance and the San Francisco/Oakland-Chicago flow has a westbound imbalance, which suggests empty reposition between San Francisco/Oakland and Chicago. NYK and American President intermodal are currently operating triangulated rail services to achieve such repositioning.

It is tempting to assume that double-stack services could divert just enough truck traffic to achieve balanced flows, but such is not the case. Diverting only one half of a two-way loaded truck movement would leave excess truck capacity seeking a backhaul at low rates. Unless trucks reposition to alter their own movement and balance pattern, it will be

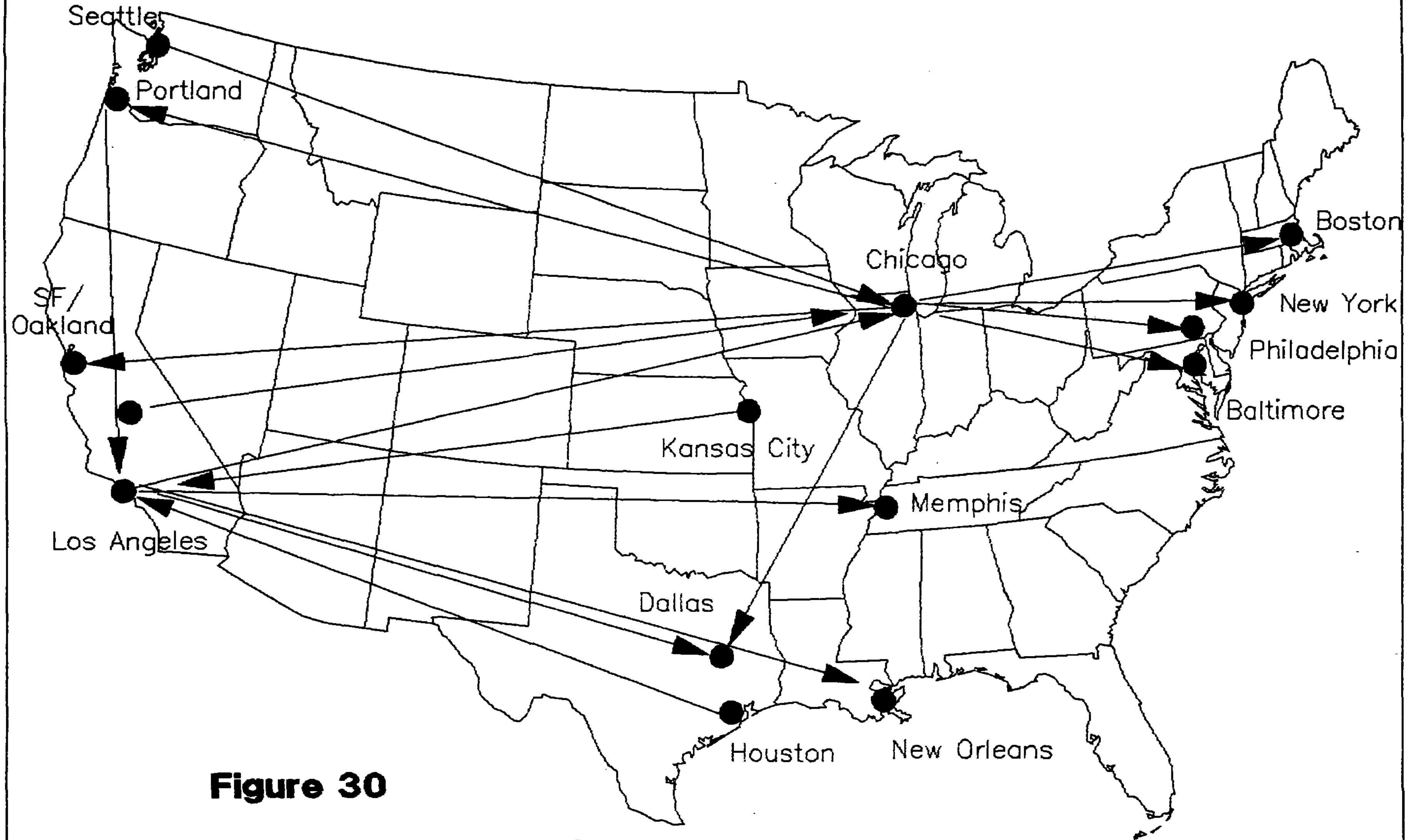


Figure 30

NET DIRECTIONAL IMBALANCES

difficult for double-stack services to "skim the cream" and achieve balanced movements at the expense of truckload common carriers.

B. RAIL INTERMODAL TERMINAL REQUIREMENTS

1. Terminal Requirements

In expanding double-stack services, railroads will typically use existing terminal facilities and equipment as long as possible. Unlike ports, railroads rarely build much in advance of demand. Once new operating needs and volumes have been established, terminal expansion will be undertaken. An intermodal terminal that will be handling double-stack trains has these general requirements:

- Loading and unloading tracks of adequate length to handle 15-28 car double-stack trains with a minimum of switching;
- Sufficient storage tracks to hold empty cars, bad order cars, and overflow equipment;
- Mechanical lift equipment capable of serving double-stack cars;
- Hostling equipment sufficient to shuttle chassis with and without containers between various locations within the terminal;
- Parking capacity for incoming containers unloaded from trains, for outgoing containers received through the gate, for empty containers awaiting loads, and for the terminal's chassis pool; and
- Modern entry/exit gates with a significant degree of automation and administrative support.

Any one of these requirements could constitute the limiting factor for a given facility. Some factors, however, such as the supply of lift or hostling equipment, can be changed more rapidly and less expensively than more fundamental factors such as the supply of land. When faced with capacity constraints, railroads typically identify the least expensive means of alleviating bottlenecks. Usually, new mobile equipment or gate modifications are tried before the terminal itself is expanded.

All of the Class I railroads were contacted regarding their current intermodal terminal operations as well as their future terminal development plans. The results indicated that the majority of the intermodal terminals handling double-stack containers will have sufficient capacity for some years to come without making significant investments. No new terminals are currently envisioned specifically for domestic double-stack operations beyond those currently in place or in progress (ie, CNW's Global II and the expansion of SP's ICTF). All railroads expect that their intermodal mix will include, but not be limited to, containers. It is thus difficult for them to plan for specialized double-stack terminals.

2. Traffic Volumes and Capacity at Major Hubs

The development and expansion of double-stack networks implies an increase in traffic at major hubs. For the hypothetical 1987 network, growth would come from two sources: conversion of boxcar traffic, and diversion of truckload traffic. Conversion of domestic piggyback traffic to containers will not increase terminal traffic volumes. Existing intermodal traffic outside the domestic double-stack network must, however, be included in any estimates of hub traffic volume. Appendix Table 7 gives consolidated traffic volumes -- double-stack, other intermodal, converted boxcar, and diverted trucks -- for the major hub BEA's. By the year 2000, intermodal traffic is expected to grow substantially. Appendix Table 8 gives hub volume estimates based on 4 percent annual growth of the intermodal portion. No attempt was made to predict the growth of diverted truck traffic. Because the intermodal growth projection already incorporates some truck diversions, a separate projection for further growth would risk double counting.

The major railroads were contacted to update existing information on the capacities of railroad intermodal terminals. Appendix Table 9 shows present and potential intermodal terminal capacity.

3. Potential Terminal Shortfalls

Table 26 compares the hub volume estimates from Appendix Tables 7 and 8 with the capacity estimates from Appendix Table 9 to determine the extent of any shortfalls and the rough cost of construction or expansion to alleviate those shortfalls. Construction or expansion costs for rail intermodal terminals vary widely, depending on:

- the local cost of land and construction labor;
- The need for pre-surfacing, demolition, trackage, and paving;
- the need for construction or expansion of gates, administrative facilities, or shops; and
- the need for terminal equipment and electronic information systems.

The cost of land alone might range from $15,000 per acre in undeveloped rural areas to $250,000 or more in major cities.

To derive a rough average of the costs for construction at major hubs, where capacity shortfalls are more likely, published cost and acreage information for three recently constructed double-stack facilities were examined:

- The SP ICTF in Los Angeles, which according to SP originally covered 150 acres and cost $80 million.

- The BN Seattle International Gateway, which covers 29 acres and cost $10.6 million.

- The south on-dock double-stack facility in Tacoma, which covers 40 acres and cost $20 million.

These three facilities together aggregated 219 acres (as originally built), and cost a total of $10.6 million, an average of $505,000 per acre. Although this figure would almost certainly not apply to any specific facility construction or expansion plan, it is a usable figure to assess the rough magnitude of capital investment required to alleviate a general shortfall.

Table 26
POTENTIAL TERMINAL CAPACITY SHORTFALL

Hub	Estimated Capacity	Hypothetical 1987 Volume	Hypothetical 2000 Volume	1987 Surplus or Shortfall	2000 Surplus or Shortfall	1987 Expansion Cost ($)	2000 Expansion Cost ($)
LA/LB	3,026,735	2,659,382	3,364,201	367,353	(337,466)		13,847,698
Seattle	1,080,141	844,907	1,144,784	235,234	(64,643)		2,652,584
Portland	584,687	594,863	768,158	(10,176)	(183,471)	417,566	7,528,613
Chicago	7,423,814	2,660,493	4,232,317	4,763,321	3,191,497		
St Paul	120,016	225,548	327,672	(105,532)	(207,656)	4,330,437	8,521,029
Detroit	569,673	246,806	334,942	322,867	234,731		
Kansas City	872,403	400,771	613,703	471,632	258,700		
Denver	644,962	141,245	235,191	503,717	409,771		
Houston	948,416	412,981	619,449	535,435	328,967		
St Louis	878,163	362,198	597,337	515,965	280,826		
Columbus	240,031	75,979	126,515	164,052	113,516		
New York	1,215,485	791,433	1,131,262	424,052	84,223		
Baltimore	418,591	184,255	278,501	234,336	140,090		
New Orleans	395,173	316,849	497,857	78,324	(102,684)		4,213,571
Atlanta	790,473	263,756	439,172	526,717	351,301		
Memphis	453,718	343,797	536,416	109,921	(82,698)		3,393,459
Dallas-Ft Worth	INC.DATA	800,277	1,013,483				
SF-Oakland	INC.DATA	827,151	1,054,579				
Philadelphia	INC.DATA	343,545	489,552				
Boston	INC.DATA	225,841	322,769				
Stockton-Modesto	UNKNOWN	344,721	396,251				
Phoenix	UNKNOWN	338,197	392,406				
Albuquerque	UNKNOWN	66,492	75,554				
Salt Lake City	UNKNOWN	181,884	232,055				
Fresno-Bakersfield	UNKNOWN	213,101	263,549				
TOTAL	19,662,481	13,866,472	19,487,685	9,137,218	4,415,004	4,748,003	40,156,955

From Table 26 it is immediately clear that there are two classes of shortfalls:

- o existing hubs requiring expansion; and
- o points without intermodal facilities requiring new construction.

The second class of shortfalls raises a serious chicken-and-egg question: Will the railroads be willing to build new intermodal facilities with the expectation of diverting boxcar and truck traffic? Points like Eugene, which are not within drayage range of existing hubs, pose a special problem in attempting to start a domestic double-stack service from scratch. One possible solution is the use of contracts to establish a traffic base large enough to mitigate the risks of facility investment.

In the long run, the railroads may shift some of the domestic double-stack train activity to private terminals. As an example, GTW is leasing a terminal 18 miles outside of Detroit to API. On the East Coast, some major steamship lines have established their own terminals. It is likely that more joint ventures and partnerships will be formed to meet the terminal requirements of domestic double-stack service operated for non-railroad entities, thus reducing the railroads' financial commitments and the impact on existing railroad terminals.

C. RAIL EQUIPMENT NEEDS

1. Domestic Containers

All indications are that international double-stack traffic will continue to move in international (ISO) containers 20, 40, or 45 feet long and 96 inches wide for the foreseeable future. Domestic double-stack traffic will travel in a mixture of these ISO sizes and domestic containers 45, 48, and 53 feet long and 102 inches wide. Thus far, the 48 x 102 size predominates in the domestic container fleet. The 45 x 102 size has been built in small numbers, and is favored by some industry participants as an ideal size for domestic refrigerated service. The 53 x 102 size has thus far been built only for American President, and is limited in its use by highway restrictions.

Growth in domestic containerization will require expansion of this fleet to accommodate conversions from piggyback trailers, boxcars, and trucks, and growth of existing domestic container traffic. Growth of international trade will require expansion of the international container fleet regardless of how many of these containers move on double-stack trains. Most domestic container traffic still travels in international containers due to the persistent imbalance of trade. Exports are predicted to grow faster than imports, gradually improving the overall balance of containerized imports and exports. An improved balance will reduce the incentive of ocean carriers to make ISO boxes available for domestic traffic, and thereby require the domestic fleet to handle a larger share of the total. Domestic movements in ISO containers will not disappear, even if imports and exports balance. An overall balance does not mean that the traffic of individual carriers and trades will be balanced, nor does it imply an even stream of traffic over the year. Idle ISO containers will continue to be available for revenue loads, domestic or international.

The current proportions of domestic and ISO containers in domestic container traffic cannot be determined directly from the available data, and so must be inferred. An analysis by Trailer Train (Intermodal Market Survey, 1989) inferred that domestic container loadings in 1988 accounted for 5-7 percent of total intermodal traffic, or approximately 270,000-300,000 loads. Of that total, approximately 100,000 loads were carried in domestic containers, and the remainder (200,000-300,000 loads) in ISO containers. With a fleet of about 8,500 domestic containers in 1988, the average container carried about 12 annual loads. This is relatively low overall utilization, since a common industry benchmark for good utilization is 10-12 annual two-way trips, with 18-24 annual loads. Some of this lower utilization, however, is due to the containers not being available for the entire year. For purposes of estimating minimum total fleet requirements, a utilization average of 10 annual round trips with 18 annual loads would be more representative.

Table 25 shows that the hypothetical 1987 double-stack network would include 1,191,684 units of existing container traffic, 1,108,664 units of existing trailer traffic, 407,561 container equivalents of boxcar traffic, and 3,236,604 units of truckload traffic. Of the 5,944,513 total annual loads, 4,752,829 (all but the existing container traffic) would require new domestic containers (assuming none were carried in surplus ISO containers. At 18 annual loads per container, this traffic volume would require 264,046 new domestic containers (Table 27).

Growth to the year 2000 would increase the existing rail portion by about 4 percent annually, or 67 percent over the 13 year period. Applying this to the 1987 trailers and boxcar equivalents suggests a need for 56,437 domestic containers by the year 2000.

In 1989 dollars, a new 48 x 102 domestic container costs roughly $8,000. The additional cost of containers needed to serve the hypothetical 1987 network, including all the truck diversions, would be approximately $2,112 million. The additional cost for the year 2000 is $451 million.

Chassis. Major intermodal ocean carriers such as American President Lines and Sea-Land Service own approximately one chassis for each two containers. This ratio can be used as a rough guideline for estimating the total chassis fleet required to support the hypothetical 1987 and 2000 double-stack networks. Approximately 132,023 additional chassis would have been required in 1987, and another 28,219 by 2000. 1989 costs were roughly $8,500 for an extendable 40/45/48 chassis. With standardization of domestic containers at 48 feet, however, extendable chassis may not be needed. A 48-foot fixed-length chassis would cost closer to $6,500, making the cost about $858 million, and the 2000 cost about $183 million (Table 27).

Double-Stack Cars. In 1988 there were approximately 2,400,000 rail container loadings. The majority were apparently on double-stack cars, of which there were about 2,400 (24,000 container spaces). The suggests that double-stack cars were making up to 100 loaded trips per year, on about one round-trip per week. This estimate implies a very high utilization, which in fact is being achieved. A five-unit double-stack

Table 27

RAIL EQUIPMENT NEEDS

	1987 NETWORK			2000 ADDITIONAL		
	Units	1987 Price ($)	Cost ($ M)	Units	1987 Price ($)	Cost ($ M)
48' x 102" Domestic Containers						
For existing trailer traffic	61,592	8,000	493	41,267	8,000	330
For converted boxcar traffic	22,642	8,000	181	15,170	8,000	121
For diverted truck traffic	179,811	8,000	1,438	-	-	-
SUBTOTAL	264,046	8,000	2,112	56,437	8,000	451
48' Chassis	132,023	6,500	858	28,219	6,500	183
Double-Stack Cars	5,281	180,000	951	1,129	180,000	203
TOTAL			3,921			837

car is therefore capable of carrying 1,000 annual container (100 trips at 10 containers each). If one container makes 10 annual round trips (loaded or empty), each double-stack cars can support a fleet of approximately 50 containers. The additional containers listed in Table 27 would therefore require an additional 5,281 double-stack cars for the 1987 network, and 1,129 additional cars for the 2000 network. At a current cost of approximately $180,000 per car, the total cost would be $951 million for the 1987 network, and an additional $203 million for the 2000 network (Table 27).

Total Equipment Needs. Table 27 summarizes the needs for domestic containers, chassis, and double-stack cars. The total investment need is roughly $3.9 billion for the hypothetical 1987 network, and an additional $0.8 billion by the year 2000. The total investment for the 13 year period is about $4.8 billion, or $366 million per year. Although high, this figure is not unattainable: the railroad industry made a similar total investment during the coal boom of the late 1970's and early 1980's, when the industry was not as prosperous as it is now. Such investments can draw on many sources, including Trailer Train and the leasing companies, and it seems likely that the railroads themselves would bear only part of the investment burden.

To the extent that container and trailer traffic outside the truck-competitive network is also converted to double-stacked containers, there will be additional equipment investment needs.

D. ECONOMIC AND FINANCIAL ISSUES

1. Profitability

Commencing in 1980 with deregulation, and accelerating with the introduction of double-stack capabilities, intermodal traffic has accounted for an increasing share of railroad revenues. For some railroads it now accounts for 40 percent of their total revenue. For others, it is still less than 10 percent. Now, however, attention is being focused more on profitability than on gross revenue.

While the average profitability of double-stack trains is perceived to be better than that of TOFC trains, many railroads do not yet consider it satisfacory. The rate cap imposed by trucks, the need for terminals and terminal labor, and the fierce competition have all tended to restrict the profitability of TOFC traffic. From time to time, some railroads officials have questioned the underlying profitability of TOFC. The cost advantages of double-stack service and the large volumes of international traffic have led most railroads to regard double-stack traffic as more profitable than TOFC. Some railroads, such as BN and CNW, regard intermodal profits as a whole to be adequate. Many railroads, however, believe intermodal profitability must increase to justify further investment.

Rates. The first constraint on profitability, as discussed in the cost criteria, is the constraint that truckload service imposes on double-stack rates. At present, customers consider intermodal service -- including double-stack service -- inferior to truckload service, and they expect a discount from truckload rates.

The comparison applies to the total intermodal transportation bill, of which the railroad linehaul rate is only one part. The third-party fee, the drayage expense, the chassis and container per diem, the terminal contractor lift charge, and the Trailer Train or leasing company equipment charges must be deducted from a total price that is already below the truckload rate before railroad revenues can be set against operating and overhead costs.

LTL and truckload carriers have announced 3-5 percent rate increases for the first quarter of 1990, giving some room for raising double-stack rates. Southern Pacific has announced intermodal rate increases of about 7 percent, indicating SP's faith in intermodal's long-term ability to reduce the discount currently offered.

Costs. Reducing the costs of double-stack service is a difficult task. Many of the costs of double-stack service are outside expenses. While one railroad can negotiate for the lowest terminal contractor costs and the lowest equipment costs, so can all other railroads. Other costs, such as motive power, diesel fuel, and maintenance, are also common to all railroad operations and all railroads. The costs specific to intermodal and double-stack service, such as marketing and customer service, have already been cut and cut again. As discussed in the cost criteria, some reductions are possible in labor costs. But cost reductions of any kind, if they become industry-wide, may lead only to further rate reductions in response to competitive pressure.

The intermodal transaction is inherently more complex than truckload service. A domestic double-stack movement may involve:

- one or more railroads;
- two terminal contractors;
- two draymen;
- two chassis pools;
- a container leasing company; and
- a third party agent.

By comparison, a truckload movement typically involves only a single trucking company and perhaps a third-party agent or broker. There are fewer operating functions and fewer people to manage in truckload carriage. The complexity of intermodal movements also creates more opportunities for costly errors and inefficiencies: the overall profitability of intermodal business can be significantly harmed by poor equipment utilization, low labor productivity, and high claims ratios, to name just a few.

2. Capital Needs

Clearances. Double-stack cars require greater clearances than any other type of railcar if loaded with two 9'6" high-cube containers up to 102" wide. Rail routes that have historically restricted piggyback or tri-level auto-rack traffic will likely be closed to double-stacks unless substantial sums are spent to increase clearances in tunnels and under bridges or overpasses. These problems are more serious for domestic traffic than for international traffic because of the greater existing and anticipated use of 9'6" high and 102" wide containers. When high-cube containers are stacked two high they require more than 20 feet of clearance over the rails, and a width of nearly 10 feet at that height. The short-term net revenue from a railroad's double-stack train service would seldom cover the required expensive clearance modifications. Without significant commitments for long-term volume, the railroad cannot realistically fund these modifications. Strategic partnerships, discussed later, will encourage the required long-term commitments.

One near-term approach to clearance problems is the use of spine cars, which achieve some of the line-haul economies of double-stacks. CSL Intermodal has recently announced a container service using spine cars between Chicago and Baltimore, where there are long-standing clearance problems. The use of spine cars also allows the railroad to start a premium domestic container service at a lower minimum volume, and consider clearance improvements as traffic volumes rise.

Overall, it appears that restricted clearances may delay, but not prevent, the development of a domestic double-stack network. Matching high-cubes with shorter containers and the use of spine cars will allow railroads to introduce domestic container service in restricted corridors without making an all-or-nothing decision on expensive tunnel and bridge modifications. It may be several years before two high-cube domestic containers can travel together over the whole network, and there may be some routes into metropolitan areas that will always have clearance restrictions. The routes with the greatest potential for domestic container movements will probably be cleared first, with lower-volume routes to follow. This process may lead to uneven network development, particularly in the Northeast, and may reduce near-term profitability.

Management Systems. Most discussions of capital needs in transportation focus on equipment and facilities. The biggest shortcomings in existing intermodal and double-stack services, however, are operational reliability, fragmentation of responsibility, and customer service. Addressing those shortcomings requires improved management systems, calling for capital investment in computerized information systems and advanced communications technologies. Information and communications systems play a central role in coordinating the activities of decentralized organizations such as railroads. Properly implemented, they can also assist in coordinating activities between two or more firms, thus reducing fragmentation. With careful design, such systems can greatly improve customer service and responsiveness by giving marketing, sales, and traffic personnel the information they need, or even making direct connections with the customers' computers. Because intermodal marketing and operations often have different information needs than other railroad departments, those needs may be poorly served by corporate information systems. For example, most railroad operations require a system capable of tracing cars, while the intermodal operating personnel and their customers need to trace trailers and containers.

The provision of improved information and communications systems may be less an issue of capital needs than one of institutional will. Railroads have repeatedly demonstrated their willingness to invest in systems and software that promise concrete productivity improvements or marketing advantages. The question is whether the railroads are willing to make a comparable investment in systems to support a potential net revenue producer, intermodal, and an intangible function, customer service.

3. Labor Issues

The central labor issues in the railroad industry are crew consist and work rules, which affect all rail operations. Railroads and rail unions have cooperated in running "sprint" trains and other "new" rail business with reduced crews (two crewmen instead of three or four). In some respects, double-stack container business is "new". The cost requirements for successful penetration of the truck market will determine whether reduced crews are necessary for a viable domestic container service, or for an already viable service to expand its market share and profitability.

Train Crew Costs. Most carriers operating in the heavy intermodal corridors have three-person crew arrangements for at least part of their operations, with productivity pay. In a few instances, the Class I railroads have negotiated two-person crews (who generally receive productivity payments) for certain intermodal service. The prospects in current labor negotiations for expanding the use of two-person crews in intermodal service seem good. A recent Santa Fe agreement calls for longer mileages and other marked improvements. Pricing competitiveness with trucks could be improved if operations could be implemented with two-person crews paid for 8 hours work rather than a set mileage. The labor unions, however, may not wish to set what they consider a dangerous precedent, but have also stated in the past that other costs should be pared down to attract this business. As the operating cost criteria illustrate, issues of pay and work rules are very complex, and defy simple solutions.

<u>Terminal and Drayage Labor Costs</u>. Because of the historic truck line exclusion from the Railroad Retirement and Railway Labor Act provisions, many railroads have operated their intermodal terminals with personnel from their truck subsidiaries (often Teamster labor). Others have engaged outside contractors with low overall wage and benefit costs. Thus, the ability of the railroads to lower terminal labor costs still further is marginal. Similarly, most drayage is done by outside trucking companies, and it has been difficult for railroad-owned truck lines to compete. The railroads do have an opportunity to reduce terminal and drayage labor costs by increasing terminal efficiency and reducing the labor time per unit, regardless of the labor pay rate. The critical problem is gate inspections and documentation, which use up the time of both terminal personnel and draymen. Both the costs and the delays involved in gate operations are significant factors in the ability of railroads to compete with truckers.

E. OPERATIONAL ISSUES

1. Highway and Street Access

A more complex, and perhaps more intractable infrastructure problem is highway and street access to rail intermodal yards and ports. Drayage is a major factor in the ability of double-stacks to compete with trucks, and a major source of delay and unreliability. Where drayage is impeded by poor access and traffic congestion, costs rise and reliability drops. The problem is most serious in major metropolitan areas (which are often port cities as well) and at inland cities where "rubber-tired" interchange takes place (particularly Chicago, but also Memphis and New Orleans).

The intermodal access problem in port cities is complicated by the container drayage peaks associated with the arrival of large container ships, some of which may discharge and load upwards of 2,000 containers in a single call. Intermodal containers have to compete with local customers for drayage service, and compete with other port and urban traffic for highway access. At peak periods, the intermodal volume can strain the system. During the worst traffic conditions in Southern California, ocean carriers pay as much as $120 for the 20-25 mile dray to UP and Santa Fe facilities.

The true extent of the urban congestion problems traceable to rubber-tired interchange is unknown, although those in the intermodal field regard it as serious in Chicago and potentially serious elsewhere. A preliminary estimate by ALK Associates indicates that as many as 1,000 trailers and containers are drayed through the streets of Chicago every weekday. Most railroad-to-railroad interchange on through bills of lading are "steel-wheeled" interchanges: the containers or trailers remain on the railcars, and the cars themselves are interchanged. Rubber-tired interchanges, where the containers or trailers are unloaded, drayed, and reloaded, result in large part from third-party movements that are billed separately over two rail segments.

The highway and urban access problem is beyond the authority of the railroads, even if they had the required funds. Some observers feel that government participation may be required. Suggestions range from exclusive drayage roads on abandoned rail rights-of-way, to improved highway exits and entrances for intermodal yards. The upcoming renewal of the Highway Trust Fund is seen as a forum for discussion of urban infrastructure problems, as well as a potential source of funds.

2. Payload Penalties and Overweight Containers

While a container may have a listed capacity greater than a piggyback trailer, when the weights of the container and the chassis are combined it will generally be more than that of a piggyback trailer or a highway trailer. This raises two issues: the "payload penalty" associated with the use of containers rather than trailers, and the potential aggravation of overweight problems.

As Table 28 demonstrates, a 48-foot long 102-inch wide domestic container on its chassis can weigh 16,700 pounds, 21 percent more than a comparable trailer, and 40-45 percent more than a highway trailer. This payload penalty will affect shippers of heavier goods that reach the weight capacity before filling the space ("weighing out" before "cubing out"). If priced on a containerload or trailerload basis, containers will be able to move about 6 percent less freight, raising the equivalent unit rate by 6 percent. With existing technology, this payload penalty is inescapable, and it must be dealt with in pricing and marketing.

The payload penalty may aggravate the overweight problem. There were problems with overweight trailers and trucks long before domestic containers were introduced, and there is little reason that overweight containers should be more prevalent. If container customers overload the container to get the same payload as a trailer, however, there may be a more widespread problem with overweight domestic containers.

3. Equipment Balance and Logistics

Equipment Balance. One operating issue created by specialized equipment such as the double-stack car is equipment balance. Heavy peak demand often requires repositioning of containers and cars. It can also create the need for chassis repositioning. The cost criteria assumed 100 percent utilization of containers and double-stack cars, a standard that is now approached by only the most effective and efficient intermodal operators. Double-stack utilization is somewhat higher than conventional piggyback cars: Trailer Train double-stacks average 360 miles per day, versus 225 miles per day for TOFC cars. If extensive empty equipment repositioning is required, equipment utilization and the economies of double-stack service will be significantly reduced.

Intermodal has been the mode of imbalance. Several strategies have been tried to overcome imbalances, but none is easy to implement or highly profitable when implemented. One strategy is to seek "backhaul" movements by offering low rates in the light direction. This strategy has been vigorously pursued by intermodal operators, but some observers note a long-term profitability problem once the lower rates become accepted as

Table 28

DOMESTIC CONTAINER PAYLOAD PENALTY

	48' x 102" Container	48' x 102" TOFC Trailer	48' x 102" Highway Trailer
Highway Weight Limit	80,000 lbs.	80,000 lbs.	80,000 lbs.
Tare Weight	8,100	13,800	12,000
Chassis Weight	8,600	--	--
Tractor Weight	15,000	15,000	15,000
Payload Limit	48,300 lbs.	51,200 lbs.	53,000 lbs.
Container/TOFC Payload Penalty	2,900	--	--
Container/Highway Payload Penalty	4,700	--	--

Source: Official Intermodal Equipment Register, September 20, 1989
Tractor weight is representative.

"standard." Many shippers have institutionalized low backhaul rates and used them to penetrate markets that would not be accessible at full cost. As carriers come closer to balancing international and domestic flows, aggressive backhaul pricing is disappearing, and shippers and consignees who used low backhaul rates will have to adjust. A second strategy is "cream skimming," attempting to carry only balanced, high-value freight. Cream-skimming, however, is an open invitation to aggressive competitors, and it is difficult to maintain for extended periods. A third strategy is "triangulation," where the return movement goes to a different destination and a short repositioning movement is accepted to gain an improved overall balance. Truck is an inherently more flexible mode and has an advantage in attempting to triangulate movements, accounting for part of the trucking industy's better overall traffic balance.

There has been a resurgence of ocean carrier interest in triangular double-stack services; e.g., Los Angeles to Chicago, Chicago to Oakland, and then repositioning to Los Angeles. Triangular services require chassis and containers in three locations, not just two. Multiple intermodal terminals can increase the administrative, inventory control, and maintenance management costs as well as the capital costs necessary to ensure adequate equipment availability.

<u>Chassis Logistics</u>. Chassis logistics can be a potential operating problem if it is not solved through contracting or other institutional means. For efficient operation, a rail terminal must always have chassis available for incoming containers (to avoid grounding and rehandling), but at the same time valuable terminal space and capital cannot be consumed by empty chassis. Unless a neutral chassis pool is used, containers must also be matched with the correct firm's chassis. This is a significant problem even when one train contains containers from several different ocean carriers; it will become a much larger problem if the railroad has to match chassis for several shippers or third parties as well.

Neutral chassis pools appear to be a workable solution to chassis logistics problems. Although they are not universally accepted, and pool chassis utilization could still be improved, there are over 50 railroad and port chassis pools with over 15,000 chassis in service. Strick Leasing has the most pools in operation, with over 20 at rail terminals and ports. The largest single international pool, and the oldest railroad pool, is the BN pool in Cicero (Chicago) operated by Transamerica ICS; this pool, started in 1985, now has over 1,500 chassis of all types, available for use by any BN customer. There are also several port and marine terminal chassis pools that serve local traffic as well as drayage. The pool at Maher Terminal, in New Jersey, is the largest of these with over 2,000 chassis. Some resistance to using chassis pools has come from the few major ocean carriers whose traffic volume can support their own chassis fleets.

4. Double-Stack Car Supply

Since Trailer Train began acquiring its fleet of double-stack cars in 1985, many of those cars have been assigned to specific railroads for periods of three to five years. Those railroads guarantee all per diem and mileage charges for the assignment period, and they manage those cars essentially as though they were their own. Railroads could, in turn, reserve those cars for the use of specific customers, principally the major steamship lines and their intermodal subsidiaries. Under this system, both the railroads and their customers could obtain the cars they needed without a direct capital investment and without a long-term obligation. This car supply mechanism reduced the risk of starting new double-stack services and encouraged expansion of the double-stack network.

The recent ICC decision extending Trailer Train's anti-trust immunity prohibited Trailer Train from assigning cars in this manner. In the future, Trailer Train's double-stack cars will be in a free-running pool. If railroads and ocean carriers deem it necessary to have a supply of double-stack cars under their own control, they will have to acquire cars (via purchase or long-term lease), use cars from leasing companies, or devise an alternative to the previous assignment system.

Since the early days of double-stacks some railroads and ocean carriers have acquired small numbers of cars. Railroads and ocean carriers are likely, however, to conserve their capital wherever possible. Railroads might follow the same strategy with double-stack cars that they have with other specialized types: acquire enough cars to protect the core traffic of long-term, high-volume customers, and use leased, pool, or off-line cars for the remaining traffic. Among the car leasing companies, only Greenbrier Intermodal (the leasing arm of car manufacturer Gunderson, Inc.) currently offers double-stack cars. This situation could change rapidly, however, as there are three manufacturers eager to sell cars, and a number of leasing companies with access to capital. Some small double-stack operators, such as Interdom, regularly use leasing company cars.

Trailer Train is likely to provide the majority of the double-stack cars, just as it provides the majority of the intermodal flat cars. The railroads themselves will have to take more responsibility for the management and control of the Trailer Train cars they are using. Cars in a free-running pool can stay on the same railroad or in the same service indefinitely, as long as they are in active use. Once pool cars are idled for some specified period, however, they can be redistributed for use by other carriers. It will thus be incumbent on the railroads to utilize pool cars fully, rather than treating them as a reserve.

To achieve this end, specific cars may be "dedicated" to specific customers or services. This mechanism is widely used to create pools of cars for major shippers of commodities as diverse as automobiles and beer. By using this well-established control mechanism, railroads may be able to create a stable supply of cars for the principle double-stack customers and corridors. Creation and management of a dedicated car system for single-line movements poses no special difficulties; it is essentially the same as any internal car management task. Interline service, however, can create problems. Under pressure for timely departures and while coping with traffic surges, one interline partner may be tempted to divert dedicated cars to its own single-line services. When car supply is short, those pressures can be intense -- witness an isolated, but verified instance of containers moving in coal hoppers in 1988. The maintenance of dedicated double-stack car pools for services involving multiple railroads will require bilateral agreements or other arrangements among the partners. Such agreements could also form the basis for purchasing or leasing decisions by the railroads involved. The most critical issues in such bilateral agreements will likely be the provisions for car tracing and information flow. Under the assignment system, individual railroads could trace their assigned cars through UMLER and TRAIN II (for the near future, they will have to rely on Trailer Train to trace dedicated Trailer Train cars). Management of dedicated car pools may require some railroads to refine their own systems and communications links.

5. Domestic Container Supply

The supply of containers for domestic traffic does not appear to be any barrier to the expansion of domestic double-stack service. Ownership of the domestic container fleet will be mixed, just as ownership of the piggyback trailer and international container fleets is mixed. The major sources of containers for domestic service will be intermodal operators, such as API and CSL, and major leasing companies, such as Itel. Railroads, notably BN and ATSF, have acquired a small number of domestic containers and will continue to do so. The decision on whether to acquire containers through purchase or long-term lease will depend, like any such decision, on financial and tax considerations rather than on operating criteria. If operators do not acquire containers, they will have the options of short-term leases or using pool containers on a per-diem basis. Domestic shippers are unlikely to acquire general purpose containers in any significant number; any shipper acquisitions would probably be specialized equipment.

6. The Operational Challenge

Current Operating Performance. There is a large gap between what is technologically possible in intermodal operations and what is now being reliably achieved. Double-stack operations have improved on piggyback operations in many areas, including transit time, schedule reliability, and damage prevention. Double-stacks have been more successful than piggyback in attracting and retaining truck traffic. Intermodal operations of all kinds, however, generally fall short of the operational standard set by trucks. Every marketing survey taken in this field has determined that service characteristics, not cost, are the primary basis of modal choice. Unless the railroads and their intermodal partners achieve and maintain a substantially higher standard of performance, domestic double-stack service will achieve only a tenuous market share, subject to constant erosion from improved truck economics.

One instructive example of what is possible is the Florida East Coast Railroad, which offers a highly successful TOFC/COFC service between Jacksonville and Miami. The route is roughly 350 miles long, much shorter than estimates of the minimum distance required for intermodal success, yet the route carried 419,354 units in 1988, ranking it among the ten largest intermodal corridors. FEC schedules seven daily departures from Miami, plus extra trains as needed. The railroad stresses flexibility to meet customer needs: FEC has a 3:00 a.m. departure from Miami to allow UPS to deliver trailers at 5:00 p.m. in Atlanta. The 350-mile trip is usually non-stop: the intermediate points of West Palm Beach and Fort Lauderdale are served separately. All trains are cabooseless, and are operated by two-person crews. FEC performs several functions that other railroads do not. FEC deliberately makes yard space available to store empty trailers and containers. FEC has invested in a substantial trailer fleet, including a recent purchase of specialized trailers for building materials and lumber (commodities not generally considered prime candidates for intermodal). It not only calls customers in advance of train arrival, but it has tractors waiting for high-priority trailers or containers. FEC also provides drayage through a subsidiary that contracts with some 35 owner-operators.

The result is that FEC has successfully attracted large volumes of truck traffic from parallel highways. Long-haul truckers give trailers to FEC at Jacksonville for the movement to Miami, and the railroad returns empties north because there is little backhaul freight from Miami. Despite the short haul, FEC has substantial business from UPS. The success of the Florida East Coast demonstrates that precise, flexible, and responsive intermodal operations are not inherently impossible for railroads, even with conventional equipment. Some of FEC's success can no doubt be attributed to its flexible work rules and the unique features of the Jacksonville-Miami corridor, but much more of it is attributable to initiative and a strong customer orientation.

Door-to-Door Reliability. The biggest shortcoming in current intermodal and double-stack operations is the lack of door-to-door reliability. Not coincidentally, poor door-to-door transit time and reliability are the reasons most often cited by shippers for using trucks rather than intermodal. Railroads monitor on-time performance of ramp-to-ramp train movements. Industry and shipper sources indicate that double-stacks have a better record than piggyback trains in this regard, although there is still room for improvement. Performance monitoring and service quality control drops off in the terminal however, and stops entirely at the terminal gate. Some railroads have taken tentative steps to monitor what goes on in and beyond the terminal. BN surveyed Seattle-Chicago movements and found that a consistent 2.5 day ramp-to-ramp movement frequently produced 12-15 day door-to-door times because of long dwell times at terminals and drayage delays. While service-sensitive customers leave trailers or containers for just a few hours, others sat in the terminal for days.

Rail intermodal transportation is a complex process involving, at a minimum, five steps:

- Origin drayage;
- Origin terminal handling;
- Rail line-haul;
- Destination terminal handling; and
- Destination drayage.

Each party responsible for a step may have achieved 95 percent on-time performance, comparable to truckload carriers. But 95 percent reliability in each of five steps yields only 78 percent reliability for the system (.95 x .95 x .95 x .95 x .95), so more than one in five shipments will be early, or, more often, late. If more steps are required for railroad interchanges or equipment positioning, reliability drops further. To achieve 95 percent overall reliability, a five-step process has to average 99 percent reliability in each step.

Lapses in reliability can be magnified by the coping mechanisms of third parties and shippers. In order to maintain overall reliability, rail customers pad schedules. If a container needs to depart on a train by Friday, a third party or shipper may have it drayed on Tuesday or Wednesday to make sure it gets out in time. If a container is due to arrive at the rail terminal on Sunday, the customer may not plan to pick it up until Tuesday. Thus, a 3-day Friday-Sunday rail linehaul quickly becomes a 6-day Wednesday-Tuesday door-to-door trip.

Getting There From Here. Railroads know how to make operations more reliable, but it requires sustained management commitment and cooperation from both carrier and outside employees. Terminal operations and drayage are the best near-term target for improving reliability.

The newest rail intermodal terminals, notable SP's ICTF in Los Angeles, have set new standards for terminal operations. The differences have relatively little to do with lift equipment or track configuration, and a great deal to do with computer support, training, and management commitment. Railroads can also learn from the best marine terminals, such as Mitsui's TRAPAC terminal in Los Angeles, which face similar issues of reliability and efficiency, and have generated numerous innovative responses.

Drayage would appear to be a prime candidate for application of the "supplier partnership" concept. The essence of the concept is a mutual commitment between a supplier of services and a purchaser/re-seller, and a recognition that they have a common interest in superior performance in the marketplace. Most railroads have sold their trucking operations, and unless they establish partnerships with drayage operators they will have no influence on a critical portion of their intermodal service. Simply put, a shipper does not care about on-time train performance, only about door-to-door reliability.

7. Overweight Containers

The issue of overweight containers has, in recent years, occasioned several studies and a great deal of finger pointing among shippers and carriers. TOFC, truck, and carload movements are all affected. Besides the immediate safety hazard to the railcar, overloading can lead to premature wear on the cars and the track structure, accidents in terminals, and hazardous train dynamics on the linehaul.

From the perspective of double-stack operations, there are two unique issues:

1. The possibility of overloading double-stack cars; and

2. The use of double-stacks to convey overweight containers that must ultimately be delivered over the highway.

By using cars with greater capacity or matching heavy and light containers in the wells, railroads can safely move containers that would exceed highway limits. Such carefully controlled loading, however, requires that loaded container weights be accurately documented. The first double-stack cars had platform or well capacities of 100,000-102,000 lbs. Current second and third generation cars have capacities of 120,000-125,000 lbs. The 125,000 capacity well, however, cannot handle two fully loaded 40'-48' containers. Good information exchange between rail customers, railroads, and rail terminal operators will be essential to avoid overloading containers and railcars, and will probably require Automatic Equipment Identification (AEI) and Electronic Data Interchange (EDI) technologies for both efficiency and reliability. The issues involved in overweight containers are currently being addressed by all parties involved.

F. CHANGES IN TECHNOLOGY

1. Lightweight Drayage Tractors

As shown in Table 28, a domestic container on a chassis is heavier than either a piggyback trailer or a highway trailer of similar cubic capacity. This extra weight handicaps domestic containers in competing for heavy freight, and may increase the likelihood that a loaded container, with chassis and tractor, will exceed highway weight limits. Most discussions of weight differences focus on the container and chassis. The highway weight limit, however, includes the weight of the tractor. Accordingly, the possibility of reducing drayage tractor weight was investigated.

Tractors used in drayage operate over short hauls, primarily in metropolitan areas, and do not require the horsepower, fuel capacity, traction, accommodations, or streamlining of modern over-the-road tractors. Drayage tractors today are often former highway tractors, and many run out their days with sleeper bunks, 250-gallon fuel tanks, wind deflectors and fairings, and all the other trappings of a long-distance, over-the-road tractor.

The weight disadvantage of a container on a chassis could be reduced if the tractors used for drayage were stripped. For drayage purposes, used highway tractors should be purchased, when possible, without a bunk, or with a cab design where the sleeper can be removed, saving 800-2,000 pounds. One fuel tank at least could be removed, saving 1,500 pounds with fuel, or 300 pounds without. The drive train could be converted to a "puller tag axle" operation, saving 400 to 500 pounds and one-half gallon of fuel a mile. All other non-essential weight, such as wind deflectors and fairings, can be removed.

A newly ordered drayage tractor should have no sleeper bunk, a smaller fuel tank, a non-powered third "tag" axle which would save the weight of one differential and a power divider, and no wind deflector or fairings. A custom-designed new drayage tractor with a tag axle, a 290-horsepower engine, 70-gallon fuel tank, no sleeper, and no wind devices would weigh (with fuel) 4000 to 5000 pounds less than a standard tandem drive, sleeper cab, 250-gallon, fairing-equipped, 350-horsepower line-haul tractor. This difference is comparable to the weight disadvantage of a chassis and container relative to a highway trailer with the same cubic capacity.

There is no reason for drayage firms not to order special drayage tractors or not to strip used tractors of excess weight. Even small firms, including owner-operators, have the small amount of capital necessary to remove unneeded components. Firms engaged in both drayage and long-haul trucking, however, may not want a single-purpose tractor. The greatest benefits would accrue to larger, single-purpose drayage firms, or to larger firms (including railroads) with a drayage subsidiary. A few drayage firms have already ordered lighter tractors.

The most promising means of encouraging the use of specialized drayage tractors and of capturing the benefits is a long-term contractual relationship between a drayage firm and a railroad, steamship line, or third-party drayage customer. Guaranteed minimum annual volumes and predictable rates would reduce the risk drayage firms would otherwise run by investing in special-purpose equipment, just as similar contracts have encouraged the railroad industry to invest in double-stack cars.

The use of lightweight drayage tractors could also be one means of reducing drayage costs and extending drayage reach from intermodal hubs.

2. RoadRailer Operations

At present, predicting the future of RoadRailer or other carless operations is chancy, even impossible. Of several RoadRailer operations that were started, only one survives: Norfolk Southern's Triple Crown service. That operation, however, is more extensive than all the previous efforts combined, and is still expanding. Moreover, Norfolk Southern reports that Triple Crown's profitability has improved.

Whether or not RoadRailer or other carless services endure, it is unlikely that they will ever serve as feeders to a double-stack network. One of the major advantages of carless technology is the low cost of terminals and terminal operations. This advantage would be offset, if not eliminated, were a container on RoadRailer chassis transferred to a double-stack car. Although RoadRailers may be more effective than double-stack trains at penetrating shorter hauls, once the RoadRailers are on the rails there is little or no point in incurring additional costs and delays by transferring their loads to double-stacks for a longer haul. Moreover, the use of RoadRailers as a feeder would be likely to introduce additional circuity, already identified as a significant constraint on the ability of railroads to compete with trucks.

The Trailer Railer system in use by the Iowa Interstate Railroad consists of a series of short platforms, each carrying the front end of one trailer (or container) and the rear end of the next. It is not technically a carless system like RoadRailers, yet it has some of the same advantages, namely a reduced need for expensive terminals or terminal equipment. As a feeder system for double-stacks, however, it would face the same obstacles: the need for a third transfer, and the added circuity and delay. As the earlier analyses indicated, terminal costs, the time required for terminal activities, and the circuity of non-highway movements are major factors restricting the ability of double-stacks to compete with trucks on service and cost.

Any combined carless and double-stack operations are more likely to consist of simply adding carless equipment to stack trains, following BN's current experiments with compatible hitches (used to attach RoadRailers to the standard coupler at the end of a train of double-stack cars). BN sees this as a possible means of serving shorter, less dense corridors.

The commercial history of carless technology has been mixed, and there is no means of confidently predicting either its success or its failure. Thus far, the strength of carless technologies has been in tightly controlled, intensively marketed servies over shorter distances. It would appear, then, that the future of carless and double-stack technologies will be separate. It must be pointed out, however, that carless technology is currently competing in the 540-1080-mile "intermodal battleground" with the same management methods as will likely be required for double-stack success.

3. Domestic Refrigerated Containers

There is one major market segment that has not been penetrated at all by domestic containerization: refrigerated or insulated commodities. Refrigerated containers are well established in international trades, but they seldom move far inland. Until the railroads can provide or support a domestic refrigerated double-stack container system, that market will remain in the hands of refrigerated trucks and piggyback trailers.

There are a number of obstacles to a domestic refrigerated container service, and many of them correspond closely to the reasons why international refrigerated containers do not usually move inland by rail. The first and most obvious obstacle to be overcome is the need for electrical power aboard trains. Marine "integral" refrigerated containers incorporate refrigeration units, but they still require an external power source. There are three basic approaches to supplying power, all of which have been tested with some degree of success:

- o large power supplies capable of supporting nine or more containers, which would be carried in one well of a stack car;
- o smaller power supplies capable of supporting five to ten containers, which would be temporarily or permanently mounted on the end platform of a stack car; and
- o the use of fully self-sustaining containers.

The second obstacle is the need for electrical power from chassis-mounted or nose-mounted "gensets" once refrigerated containers are taken off the train. Gensets and compatible chassis would have to be available at inland terminals. Gensets are probably not a problem in port cities, where they are available for international containers, but they may be expensive to stock at inland points.

Third, refrigerated containers require monitoring, and perhaps servicing, in transit to ensure consistent performance and product quality. Truckers can and do monitor the temperature and condition of a refrigerated load, and take corrective action if needed. It is far more difficult to monitor loads on a double-stack train, and more costly.

G. MOTOR CARRIER DEVELOPMENTS

1. Sensitivity of Double-Stack Traffic

The cost criteria yielded a relationship between truckload operating costs, double-stack operating costs, drayage distance, and the minimum length of haul over which double-stacks could be price-competitive with truckload carriers. This relationship is, of course, sensitive to changes in truckload operating costs, which in turn could be affected by industry trends or public policy decisions. The major motor carrier developments that could significantly affect the emerging network of double-stack services are:

- o changes in truck size and weight limits;
- o changes in truck labor and fuel costs; and
- o changes in LTL motor carrier operations.

2. Truck Size and Weight

The major potential development from the view of double-stack operations would be substantial increases in truck size and weight limits. At issue is, first, the permissible configuration of truck combinations moving over interstate highways; second, the gross vehicle weight limit, and related axle loading limits and bridge formulae; and third, the access such larger vehicles will have to cities and roads off the Interstate highway system.

Proposals for increases in truck sizes mainly concern Large Combination Vehicles (LCVs). The most attractive combinations to truckload carriers, and the greatest threat to railroads, are twin 48-foot trailers.

Increases in the gross vehicle weight from the present 80,000 pounds would also be of concern to the railroads. The boxcar traffic considered potentially containerizable and divertable to double-stacks includes a number of such commodities. Even if truck sizes were not increased, an increase in the gross vehicle weight limit would increase the ability of truckload carriers to compete for such traffic.

Access questions for LCVs are serious: ordinary highways and streets, particularly the intersections, cannot handle the largest combinations. Where triple 28's are legal, they are operated as triples only on selected routes, and moved as doubles or singles over other highways. The access problem may be more serious for truckload operators trying to provide door-to-door service with twin 48's.

Truck size and weight issues are inescapably linked to the condition of the highway infrastructure. Controversy has raged for years over the motor carriers' "proper" share of highway construction and maintenance expense. That controversy is not likely to be resolved, but it is likely that any increase in truck size, truck weight, or truck access, will be accompanied by increases in fuel taxes, user fees, or other governmentally imposed costs. The amount and incidence of such cost increases will be an outcome of the political process,

Impact on Railroad Traffic. At least two studies have been done of the potential effects of LCVs on railroad traffic. The first study, by the U.S. DOT Transportation Systems Center, was completed in May, 1986. Using an elaborate modeling methodology, that study found that a 1990 LCV network would divert rail traffic worth $5.1 billion in annual rail revenues, and reduce rail revenues on other rail traffic by $1.8 billion annually. The second study, by the Association of American Railroads (AAR), was released in June, 1989. It considered the impact of a nationwide network of twin 48's on railroad traffic, both traffic diverted and revenues reduced because rates would have to be held down to prevent further diversions. The AAR study concluded that a nationwide network of twin 48's would have reduced 1986 revenues by $3.7 billion from a total of $26.2 billion. Moreover, the AAR study estimated that net operating revenues would decline by $1.6 billion from a base of only $3.1 billion, a 52 percent loss of net revenue. Of the revenue loss estimated by AAR, $156 million was in intermodal traffic.

Effect on Length of Haul. The AAR undertook an analysis of the estimated 1986 operating costs of a 134,000 lb, twin 48-foot truck combination (the so-called Bridge Formula B truck). Applying the percentage increases estimated by the AAR for the three truck operating cost categories used in the cost criteria yields an estimate is $.98 per mile for the 1989 operating costs of twin 48's.

Estimated 1989 Operating Costs Per Mile
Twin 48-Foot Trailers

	1989 One 48-Foot	Percent Increase*	1989 Twin 48-Foot
Equipment	$ .31	50.6	$ .47
Fuel	.20	36.7	.27
Labor	.20	22.2	.24
TOTAL	$ .71	38.5	$ .98

*"Analysis of Truck Size and Weight Increases", Intermodal Trends, Association of American Railroads, Volume I, Number 12, June 30, 1989.

Assuming the same utilization as was employed in our cost criteria (80 percent), the cost per loaded mile would be $1.23 for the combination, or $.62 per mile per trailer, versus $.89 per mile for a single trailer at present.

The result of the operating cost difference alone would increase the minimum competitive rail haul from 725 miles to 1,212 miles. Numerous double-stack network links and volumes that would be jeopardized. For all practical purposes, there would be no double-stack operations in the eastern United States, except trains to and from the West Coast.

Unless the economics of twin 48-foot trailers are offset by substantial increases in fuel costs, labor cots, fuel taxes, or other costs, double-stack services will find it very difficult to compete with twin 48's on any but the largest transcontinental routes and still offer shippers the discount they have come to expect.

The reason that railroad double-stack services are so vulnerable to reductions in motor carrier costs is that they compete on price. If double-stack services could charge the same prices as average motor carriers using twin 48's, the minimum rail length of haul would drop from 1,212 to 995 miles.

3. Driver Shortages and Labor Costs

After a long period in which real trucking labor costs declined, due in part to reduced union representation, they have begun to rise. A report by Data Resources, Inc. in the first half of 1989 found that the trucking labor costs rose 7 percent over the 1988 averages. The recent increase in real labor costs has been attributed to a nationwide shortage of qualified truck drivers. Not only have trucking firms had to pay higher wages, but their recruitment and training expenses have risen as well.

The reasons for driver shortages are complex, and beyond the scope of this study. An ongoing shortage of drivers would definitely increase truck labor costs, although it is not possible to say by how much. One indication of the possible impact is the difference that truck labor cost increases would have in the minimum length of competitive double-stack haul. Each additional penny per mile in truck labor costs drops the minimum length of a competing double-stack haul by 11 miles.

4. Fuel Costs and Fuel Taxes

Over the last decade, diesel fuel costs have defied most attempts at forecasting, but there seems to be a consensus that fuel prices will increase in the long run. The current cost is roughly $1.12 per gallon. Factors other than oil prices can also affect diesel fuel costs to truckers. Truck emissions standards for 1994 are expected to require a "cleaner" fuel at an additional cost of 3-4 cents per gallon, as well as increasing other operating and maintenance costs. Fuel consumption in the truckload segment now stands at about 5.6 miles per gallon. An increase of 4 cents per gallon would raise the estimated fuel cost per mile from $.20 to $.21. As with a penny per mile labor cost increase, this increased fuel cost would reduce the minimum length of haul for double-stacks by 11 miles.

A more dramatic change would result from increased fuel taxes, which have been proposed as a means of reducing the federal deficit. The range of increase under consideration runs from 5 cents to 25 cents per gallon. The table below shows the effect of various taxes, with and without the effect of emission standards, on the minimum length of haul for a competitive double-stack service.

Impact of Fuel Tax Increases
and Emissions Standards
on Minimum Competitive Double-Stack
Length of Haul

Fuel Tax Increase	Without Emission Standards (Miles)	With Emission Standards (4¢/gal.) (Miles)
None	725	717
$ .05	715	707
.10	705	697
.15	696	683
.20	686	678
.25	676	668

The most drastic increase, a 25 cent per gallon tax and a 4 cent per gallon emissions cost, would increase trucking costs by 5 cents per mile, and reduce the competitive length of haul for double-stacks by 55 miles, from 725 to 670.

5. LTL Trucking

The potential of double-stack services to provide economical linehauls for Less-Than-Truckload (LTL) truckers may be limited by institutional constraints within the motor carrier industry, or between motor carriers and railroads. Despite numerous public proclamations of "partnership" over the years, only a few railroads and LTL motor carriers (other than UPS) have substantial cooperative traffic. One approach to eliminating intermodal barriers has been taken by Union Pacific in its acquisition of Overnite Transportation Company. The question remains, however, whether multi-modal ownership or other measures can achieve the full potential of double-stack operations for cooperative rail/truck service.

The intermodal share of LTL truck traffic is small, but growing: 2.66 percent in 1986, and 3.64 percent in 1988. Some of the largest LTL firms use intermodal services significantly more often: Roadway currently moves about 8.7 percent of its traffic intermodally. The use of intermodal service by LTL firms is not well publicized, because those firms do not want to share in intermodal's poor service reputation among shippers. Rail intermodal service in any form, however, is not likely to supplant highway carriage for the bulk of the LTL business. In 1987, the average length of haul for Class I and Class II motor carriers was just 489 miles, well below the estimated competitive range for double-stacks.

Class I LTL motor carriers use intermodal service, almost always piggyback, as:

- a substitute or supplementary service in main corridors, often when the supply of drivers is tight:

- a means of penetrating new markets, especially where backhauls are difficult to obtain; or

- a separate service provided through subsidiaries.

For the most part, however, LTL (and truckload) motor carriers seem to consider cooperation with the railroads on intermodal traffic to be a necessary evil. The tight control that LTL carriers maintain over their operations will require real, functioning partnerships with the railroads, not merely a public relations handshake, if a substantial part of their traffic is ever to move intermodally.

One barrier to the use of domestic double-stack container service by LTL motor carriers is the container itself. Many LTL carriers have standardized on 28-foot "pup" trailers, which, when run on the highways in pairs, maximize the cubic capacity for a "go anywhere" truck combination while also maximizing flexibility. These same 28-foot trailers are used intermodally. LTL carriers may be reluctant to introduce another size or type of equipment, such as a 48-foot domestic container, into their operations. Railroads or stack-train operators would have to provide LTL motor carriers with a powerful incentive, and a high standard of service, to attract significant portions of LTL traffic.

H. CHANGING RAILROAD ROLES

Until the 1980's, railroad intermodal functions were neatly categorized in a series of TOFC/COFC "Plans." Now, railroad intermodal contracts can cover any conceivable combination of service and equipment, and can therefore be tailored to the needs of individual customers. As contracts and service offerings have evolved, railroad roles have changed.

Railroads have been withdrawing from intermodal ownership since the growth of Trailer Train. Railroad-owned trailer fleets have declined, with only a few recent orders, and are not being replaced with large fleets of domestic containers. Railroads are also relying on ocean carrier chassis and neutral chassis pools run by leasing companies rather than acquiring chassis. There are exceptions to these general trends. Santa Fe has maintained its trailer fleet and its commitment to trailer traffic. CSL has also recently replaced part of the former CSX trailer fleet. Other railroads have acquired small numbers of trailers or containers for particular customers or traffic segments.

Traditionally, railroad operating departments had responsibility for intermodal terminals. In the 1970's and 1980's, however, some railroads began turning intermodal terminal operations over to subsidiaries or going outside to contract for terminal operations. This trend has gathered momentum because:

- railroads recognized that intermodal terminal operations were specialized, and vastly different from other terminal operations;
- intense competition in the deregulated market put pressure on both costs and performance;
- smaller facilities had to be upgraded, consolidated, or closed; and
- double-stack services put a greater burden on intermodal terminals.

Ocean carriers, their subsidiaries, and multimodal companies have begun to operate inland rail terminals. Perhaps the most prominent example is APC's terminal in South Kearny, New Jersey. Although near the New York-New Jersey ports, this yard functions as an inland terminal for API's double-stack train service. "K" Line's subsidiary Rail Bridge Terminals Corporation also has its own East Coast terminal, E-Rail, in Elizabeth, New Jersey. Railroads have entered into partnerships with ports (SP's ICTF) and multimodals (API's Woodhaven terminal served by Grand Trunk Western) to build and operate facilities devoted exclusively to container traffic. It seems unlikely that any uniform pattern will appear in the near future, since the solution for a given terminal depends on the customers, the facility, and the operating and commercial philosophies of the railroad.

The roles of regional railroads in double-stack operations and domestic containerization range from substantial and growing, to none and static. Where they do have a role, regional railroads either serve as final links in longer movements, or as originators or terminators of specific traffic flows.

In the first category are large and established Class 1 regionals such as Soo Line, New York, Susquehana & Western, and Grand Trunk Western. Each of these carriers originates and terminates double-stack trains that are interchanged with transcontinental railroads. Florida East Coast participates in interchange traffic as well as operating its own busy Jacksonville-Miami intermodal traffic, but does not yet operate double-stacks. Illinois Central at one time carried Southern Pacific double-stack trains between St. Louis and Chicago, but the current routing uses wither BN or Soo Line from Kansas City instead. Kansas City Southern has begun a unique dedicated double-stack operation to move imported coffee inland from Gulf ports, using high-capacity Type 3 double-stack cars capable of carrying 20-foot containers in each well. Other regionals such as Iowa Interstate and Toledo Peoria & Western, and even short lines, such as Stockton Terminal & Eastern or Modesto & Empire Traction, originate or terminate double-stack and other domestic container movements for specific major customers.

Overall, the railroad role in domestic double-stack service is still centered on the provision of line-haul transportation and terminal services, marketed wholesale to third parties and other non-railroad intermodal operators. Retail marketing and control of the container fleet is largely in the hands of those third parties and other intermodal operators.

As the double-stack network expands, railroads have come up against the limitations of their own systems: they cannot offer single-line service to all the hubs their customers would like to reach. This has been overcome by three different means. The first is merger or purchase: extension of intermodal service played a major part in the SP/DRGW merger, the SP purchase of Soo Line and CMW line segments, and the Santa Fe service into St. Louis. The second is interline coordination, typified by the Sant Fe-Burlington Northern "Voluntary Coordination Agreement" to jointly market inermodal traffic through Avard, Oklahoma. The third, and most ambitious approach, is the creation of a national network by non-railroad intemodal operators through contracting for line-haul service and/or terminals. API and CSL Intermodal have taken this approach, and have come the closest to achieving a true national network.

VI. IMPLICATIONS FOR PORTS AND OCEAN CARRIERS

A. COMPATIBILITY OF DOMESTIC AND INTERNATIONAL DOUBLE-STACK SERVICES

1. Compatibility Issues

The growth of domestic containerization raises four compatibility issues:

1) physical compatibility of international and domestic containers;

2) commercial compatibility of international and domestic container services;

3) operational compatibility of international and domestic rail container traffic; and

4) treatment of international and domestic containers at ports.

The results of this study indicate that the compatibility of international and domestic double-stack containers and services will not be a serious impediment to expansion of the network, or to economical and efficient service for both types of traffic. There are numerous problems to be overcome, and solutions will require time, money, and management attention. Individual firms may find that some of these problems have serious consequences for their own operations. Nonetheless, the potential benefits to all parties appear great enough to justify the effort required to resolve compatibility issues.

2. Physical Compatibility

Sizes and Size Mix. There has been a good deal of concern over the intermingling of domestic and international containers of different sizes. International containers currently come in 20-foot, 40-foot, and 45-foot lengths. All marine containers are the same width: eight feet.

The heights range from 8 feet to 9 feet 6 inches (high cube). Containers built especially for domestic service come in 45-foot, 48-foot, and 53-foot lengths, with the 48-foot length predominant. Burlington Northern has introduced a small number of 24-foot domestic flatrack containers, primarily for forest products. All of these containers are 9 feet 6 inches high, and 102 inches (8 feet 6 inches) wide.

Among the international sizes, the 40-foot container predominates. As shown below, 40-foot containers account for 71 percent of the containers passing through, for example, Southern California.

1988 Container Size Mix

Size	Los Angeles/Long Beach
20'	28%
40'	71%
45'	1%

Source: 1988 PIERS Data.

The mix varies only slightly by direction. In Southern California, 40-foot containers accounted for 69 percent of the imports and 73 percent of the exports. The mix of international containers is changing, although slowly. Since there are roughly 5.5 million TEU in service worldwide, new purchases make only a marginal difference in the fleet. But the major purchasers of new 45-foot containers are APL, Maersk, NYK, "K" Line, and Sea-Land, so the new containers will show up in double-stack operations more often than their overall prevalence would suggest. Industry estimates indicate that roughly 40,000 such containers will be in service by the end of 1989, including additions to the carrier fleets mentioned above and leasing company fleets.

The marine fleet is also getting taller, as the number of "high cube" containers (9 feet or 9 feet 6 inches) grows. By the end of 1989, high cube containers are expected to account for roughly 7 percent of the 5 million TEU in the world fleet. New 45-foot containers are normally also high-cube containers. Like the 45-foot containers, high-cube containers are being deployed most rapidly by the steamship companies most involved in double-stack services.

Ocean carriers do not presently use 48-foot or larger containers in regular international service, nor do they use containers with outside widths greater than 8 feet. The ability of ocean carriers to use larger containers is limited by the configuration of cellular containerships.

The fleet of domestic containers has grown rapidly, but it is still very small compared to the volume of marine containers moving inland. The vast majority of domestic containers are 48 feet long, 102 inches (8 feet 6 inches) wide, and 9 feet 6 inches high. The so-called "48 x 102" size also accounts for virtually all domestic containers on order (except for the small number of 24-foot containers ordered by BN). Since domestic containers are not meant for international shipments, there is no requirement to build them to international standards. They do, however, have standard corner castings located at 40-foot positions on the bottom to permit stacking on marine containers.

The International Standards Organization (ISO) is considering a new standard for not only longer, but wider marine containers, the so-called "wide body" containers. The proposed 49-foot ISO container has a width of 8 feet 6 inches and a height of 9 feet 6 inches. If a new "wide body" container standard would provide for castings to match 40-foot containers (as has been done with other large containers), a 49-foot, 102-inch marine container could be handled on the top tier of IBC cars. Subsequent orders of double-stack cars would likely provide for any ISO standard that stack-train customers plan to use. There is, however, strong opposition to the adoption of the "wide body" standard in the U.S. from commercial interests. Whether it will be adopted as an ISO standard is problematical at present.

<u>Moving and Stacking</u>. In order to integrate domestic and marine containers into a common intermodal network, two physical attributes of

domestic containers must be accommodated: size (length and width), and strength (stacking height). The size incompatibility has been addressed in the double-stack arena by increasing the well length on new double-stack cars to accommodate larger containers on the bottom tier, and by installing compatible corner castings with 40-foot spacing on containers that exceed the traditional 40-foot length, permitting IBC cars to accommodate the larger containers on the upper tier. A 45-foot, 48-foot, or 53-foot container (above a 48-foot well) can be stacked on a 40-foot container and linked to the lower 40-foot container by latching devices positioned on 40-foot spacing. In response to the proliferation in container lengths, builders are providing new double-stack cars that can handle all container lengths in the wells: 20, 24, 40, 45, and 48 feet (Figure 31). On the top tier, the cars can handle up to 53-foot containers. Although many existing cars have some loading restrictions, the loading problem will be reduced as the fleet expands. The problems of loading a mixed fleet of double-stacks will be no worse than loading the existing and more varied mix of TOFC/COFC cars.

Marine containers can be stacked six high aboard ship or in the terminal, but domestic containers are usually stacked only two or three high in the terminal. This disparity could be a problem in a marine terminal if both types were handled together, but domestic containers will rarely come to rest in a marine terminal. In the rail yard, operations are geared to prompt loading of the container to the car or prompt drays from the car; there is little room for container storage, and seldom any equipment for stacking containers more than three high.

The current or anticipated mix of international and domestic container sizes will not create significant physical compatibility problems for double-stacks as long as new, larger containers have attachment points in compatible locations. The IBC car can take virtually any combination of containers, and terminal stacking differences are both minimal and avoidable. Indeed, Gunderson advertises its Type 3 "MaxiStack II" car as the "terminal manager's car". The mix of container sizes and types coming through the rail terminal gate will continue to command management and clerical attention, regardless of whether the containers are domestic or international, but it would more accurately be regarded as an inconven-

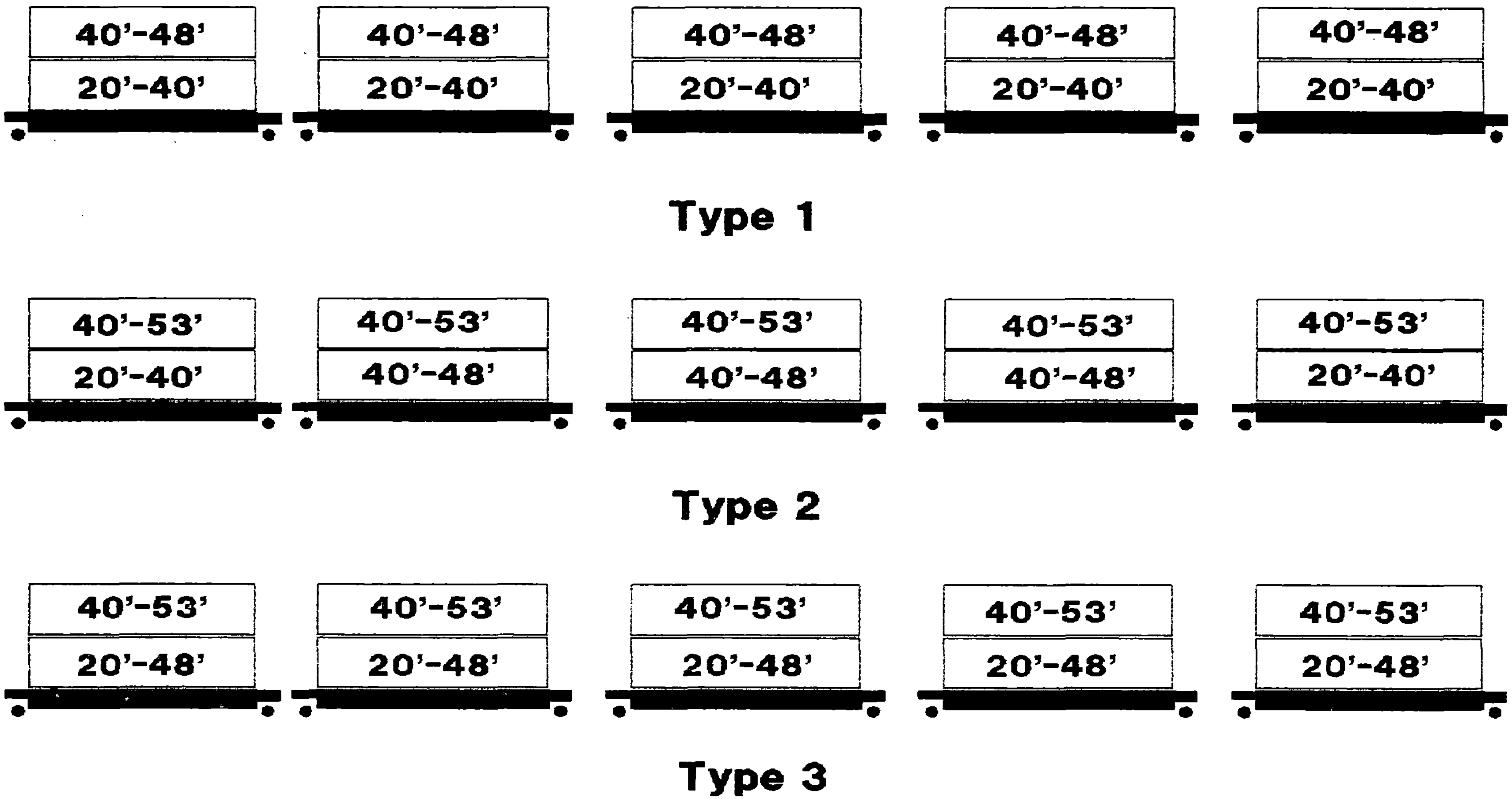


Figure 31

RECENT 125-TON IBC STACK CAR TYPES

Source: Greenbrier Intermodal

ience to be dealt with rather than a stumbling block to development of a double-stack network.

One source of relief may be the further development of Automation Equipment Identification (AEI), which permits computerized equipment to ascertain the identity (serial number and reporting initials) of passing equipment, and of Electronic Data Interchange (EDI), which enables railroads, ocean carriers, and other intermodal participants to exchange information in advance of the movement, enabling operating personnel to plan accordingly.

3. Commercial Compatibility

Marketing and Backhaul Solicitation. Once APL and Union Pacific started regular double-stack operations in 1984, other ocean carriers and other railroads pursued double-stack traffic with varying degrees of enthusiasm. One critical issue for both ocean carriers and railroads was backhaul solicitation. Double-stack services were begun during a period of strong import imbalances, leaving a large volume of containers to be returned empty unless westbound backhaul freight could be found.

Were the railroads to attempt large scale retail marketing of domestic container service, there could be a serious conflict with the backhaul marketing of their ocean carrier clients to domestic third parties. There are, however, mitigating factors. Railroad plans for retail marketing of domestic container services directly to shippers and receivers are extremely limited. Many railroads have always marketed intermodal services directly to the largest industrial customers, and marketing domestic container services that way will not disrupt existing relationships.

Retail marketing will remain in the hands of third parties for the immediate future. Ocean carrier and multimodal subsidiaries will figure prominently in that third party activity.

Customers or Competitors? Perhaps the most important change is the growing inland presence of ocean carrier subsidiaries and multimodal companies. The formation of intermodal transportation companies has blurred traditional demarcations. Today, a railroad's major customer on one intermodal rail corridor may be one of that railroad's bigger competitors on another intermodal rail corridor. For some railroad/customer relationships, there ceases to be a distinction between international and domestic movements: in many if not most cases, railroads do not know or care whether a given shipment is domestic or international, only where it is to be loaded or unloaded from the railcar.

The proliferation of intermodal transportation companies has exacerbated this "competitor or customer" problem for the railroads. At least five steamship lines have U.S. subsidiaries that can compete with the railroads. The issue of commercial compatibility is less an issue of the type of cargo, domestic vs. international, than of the complex interaction of railroads, intermodal transportation companies, and third-party vendors. This is not a new problem: it began with the first shippers agent who tendered a TOFC trailer that the railroad could have solicited directly. The competition for the same market has since gone in two opposite directions: some railroads have given up direct solicitation to work exclusively with third party vendors, while other railroads have started direct sales efforts (e.g., Conrail Mercury).

4. Operational Compatibility

The demand for rail carriage of international containers adds significant new cargo volumes, and thus trains, to the U.S. rail corridors, particularly the major mainline routes that connect West Coast ports with Midwest and Eastern intermodal hubs. Minilandbridge between Los Angeles and New York is new cargo for the railroads, because it moved by water prior to 1972. Microlandbridge between Los Angeles and Chicago is partially new; a relatively short New York to Chicago movement is replaced by a longer Los Angeles to Chicago move.

Table 29 shows actual 1987 and projected year 2000 import, export, and total international container flows, in thousands of FEU, between nine port regions and eight destination regions (Southern and Northern

Table 29
INTERNATIONAL IMPORT CARGO FLOWS
BY RAIL CORRIDOR
(000's FEU)

Destination Region	California Total	Pacific Northwest	Mountain States	Upper Midwest	Lower Midwest & Gulf	Northeast	Mid-Atlantic	Southeast	Total	Likely Intermodal Share (%)	Local Share (%)
Import Port Region Year: 1987											
So. California	261	6	9	99	60	185	27	20	667	60.9%	39.1%
No. California	67	2	4	8	3	32	2	2	120	44.2	55.8
Pacific Northwest	26	30	4	60	10	103	9	4	246	87.8	12.2
Mtn. States	0	0	0	0	0	0	0	0	0	n/a	n/a
Upper M.W.	0	0	0	1	0	0	0	0	1	0.0	100.0
Lower M.W. & Gulf	7	1	3	10	37	32	2	15	107	70.1	29.9
Northeast	24	3	1	53	9	504	16	11	621	18.8	81.2
Mid-Atlantic	8	2	3	31	5	63	58	16	186	66.1	33.9
Southeast	9	0	0	12	6	52	15	101	195	48.2	51.8
TOTAL	402	44	24	274	130	971	129	169	2,143		
Year: 2000											
So. California	441	11	15	167	101	312	45	33	1,125	60.8%	39.2%
No. California	113	4	6	13	5	54	3	4	202	44.1	55.9
Pacific Northwest	44	50	7	101	17	174	15	7	415	88.0	12.0
Mtn. States	0	0	0	0	0	0	0	0	0	n/a	n/a
Upper M.W.	0	0	0	1	0	0	0	0	1	0.0	100.0
Lower M.W. & Gulf	7	1	3	10	35	30	2	14	102	70.6	29.4
Northeast	40	4	2	89	16	839	27	18	1,035	18.9	81.1
Mid-Atlantic	13	4	5	52	8	105	96	26	309	66.0	34.0
Southeast	15	1	1	19	9	85	25	146	301	51.5	48.5
TOTAL	673	75	39	452	191	1,599	213	248	3,490		

Source: Bureau of the Census

Table 29

INTERNATIONAL EXPORT CARGO FLOWS BY RAIL CORRIDOR (000's FEU)

Export Port Region	Origin Region: California Total	Pacific Northwest	Mountain States	Upper Midwest	Lower Midwest & Gulf	Northeast	Mid-Atlantic	Southeast	Total	Likely Intermodal Share (%)	Local Share (%)
Year: 1987											
So. California	153	4	7	30	55	8	13	15	285	46.3%	53.7%
No. California	105	3	4	9	24	2	4	7	158	33.5	66.5
Pacific Northwest	4	184	25	24	9	6	8	4	264	30.3	69.7
Mtn. States	0	0	0	0	0	0	0	0	0	n/a	n/a
Upper M.W.	0	0	0	2	0	0	0	0	2	0.0	100.0
Lower M.W. & Gulf	9	1	7	7	132	5	7	59	227	41.9	58.1
Northeast	2	2	3	34	3	139	17	2	202	31.2	68.8
Mid-Atlantic	1	0	1	13	3	11	130	45	204	36.3	63.7
Southeast	1	0	1	6	8	6	24	114	160	28.8	71.3
TOTAL	275	194	48	125	234	177	203	246	1,502		
Year: 2000											
So. California	327	8	14	65	116	17	27	32	606	46.0%	54.0%
No. California	225	6	8	18	50	5	8	14	334	32.6	67.4
Pacific Northwest	8	392	53	51	20	13	17	9	563	30.4	69.6
Mtn. States	0	0	0	0	0	0	0	0	0	n/a	n/a
Upper M.W.	0	0	0	7	1	0	0	0	8	12.5	87.5
Lower M.W. & Gulf	27	2	22	22	391	14	21	176	675	42.1	57.9
Northeast	4	4	6	73	6	296	36	5	430	31.2	68.8
Mid-Atlantic	2	0	1	29	7	24	278	96	437	36.4	63.6
Southeast	3	0	1	13	20	14	53	252	356	29.2	70.8
TOTAL	596	412	105	278	611	383	440	584	3,409		

Source: Bureau of the Census

California being combined into one destination region). The two right-hand columns of the table give the likely intermodal share (i.e., those containers destined outside the local hinterland) and the local share (i.e. those cargoes consumed within the local region, or distributed by the consignees outside the local region independently of the ocean carriers). Table 29 incorporates projected annual growth rates of 4 percent for imports and 6 percent for exports, derived from the Manalytics/WEFA Bilateral World Trade Forecast.

Imports on the four top intermodal corridors are projected to grow significantly in the next decade: Southern California, to 684,000 FEU; Pacific Northwest, to 365,000 FEU; Mid-Atlantic, to 204,000; and Northeast, to 196,000. The rail corridors with the greatest demand are eastbound from Southern California and the Pacific Northwest, westbound and southbound from the Northeast, and northbound and westbound from the Mid-Atlantic ports.

The major export port regions are Southern California (19 percent of 1987 exports), Pacific Northwest (17.6 percent), and the Lower Midwest and Gulf Coast (15.1 percent). The three port regions are projected to experience significant export growth, with the lower Midwest and Gulf growing the fastest; from 227,000 FEU in 1987 to 675,000 FEU in 2000, a compound annual rate of 8.7 percent. About 42 percent of this year 2000 traffic is expected to be intermodal, although its exact routing cannot be predicted.

One crucial observation is that many of the flows in Table 29 are, and will remain, discretionary. The inland regions of origin and destination are fixed, but the exact rail hubs are not. The coastal ranges may be fixed, but the ports are not. For example, a container from Japan now moving via the Port of Los Angeles, a double-stack train to St. Louis, and a dray to a consignee in Indianapolis, could easily be shifted to the Port of Seattle and a double-stack train to Chicago, and drayed from Chicago instead. Likewise, an exporter in St. Louis could choose any of several rail routes and Atlantic Coast ports for a shipment to Europe. Because the flows are discretionary, their final routing will depend on the business strategies of the carriers. The tables reflect the current proportions.

International container flows may therefore have much more flexibility than domestic flows to adjust traffic balance and avoid heavily trafficked corridors. Some examples have already surfaced in the form of "triangle" routes, whereby eastbound containers originate at one port region (e.g. Southern California) and westbound containers arrive at a different port region (e.g. Northern California) to match the vessel's port rotation. In this arrangement, double-stack cars with or without containers are repositioned the relatively short distance between port regions.

5. Treatment at Ports

Potential Port Congestion. Until very recently, virtually all double-stack services originated or terminated at port cities, and were operated primarily to serve international traffic. The growing volume of domestic traffic carried by those services and the prospect of extensive domestic services have led to some concern over the handling of international and domestic containers in port-area facilities. The development of on-dock rail facilities prompts even stronger concerns that such facilities could be congested by an influx of domestic containers. Congestion on port-area highways and streets is also a matter for concern, particularly in Southern California.

The compatibility of domestic and international containers at ports is an issue because of the diverse distribution requirements of the two container services. Railyards serving domestic shippers and consignees are not usually adjacent to the port. Domestic container traffic between the railyard and the domestic customers is not congruent with the international container flows between the port serving customers in the local hinterland. If the domestic containers arrived at the port (i.e., at an on-dock or near-dock facility), their volume would necessarily increase congestion at the port, increase delivery time to the domestic consignees, and increase cost for the domestic consignees or shippers. Just as the ocean carrier does not want to dray international containers long distances to and from an intermodal ramp, the domestic shipper does not want to dray domestic containers long distances from and to the port, or pay for longshore labor.

As earlier portions of this study have established, there are three sources of traffic for a domestic container service: rail piggyback traffic, other rail (boxcar) traffic, and truck traffic. Existing rail piggyback traffic will most likely be the largest short-term source with relatively less boxcar traffic being converted. Truck traffic will take longer to convert. The immediate effect on most rail facilities would be conversion from trailers to containers, rather than an influx of new traffic.

In the many ports served by existing rail intermodal yards that also handle trailer traffic, the conversion from trailers to containers would not add traffic. Few intermodal yards are facing capacity constraints at present, and those that do are being expanded. There seems little risk of a short-term congestion problem so severe that it would impede the growth of either international or domestic double-stack services. The long-term outlook for facilities depends on profitability: if domestic double-stack service is profitable, railroads can and will invest in the necessary facilities.

On-dock facilities, however, cannot be expanded significantly in most cases without impinging on land required for marine terminal operations. Moreover, on-dock facilities are usually built with port funds to provide efficient, expeditious rail service for ocean carriers' international containers. An influx of domestic containers might defeat the purpose of on-dock facilities.

Incentives and Control. Fortunately, there is little incentive for any participant in domestic container traffic to send containers with domestic freight to crowded on-dock facilities. Domestic freight taken by rail to on-dock facilities would have to be drayed back out to domestic destinations at a substantial additional cost for drayage and gate fees. With railroad-owned facilities in the same area, domestic shippers would have every reason to avoid costly trucking into port facilities. Thus far, railroads typically regard service to on-dock facilities as more costly than handling traffic in their own yards, especially when the customer is paying for the drayage. Railroads thus have no incentive to bring domestic containers to on-dock facilities.

There are only a few on-dock rail transfer facilities now handling significant traffic at U.S. ports: Tacoma (two facilities), Portland, Seattle, Long Beach, and New York/New Jersey. None is yet regarded as congested. In the course of this study it was found that only two, those in Tacoma, regularly handle any domestic containers. With ample current capacity, Maersk and Sea-Land use their on-dock terminals to handle some domestic backhaul movements intermingled with their international cargo. It is anticipated that this practice will end when the rise in exports balances the import flows, or when the on-dock transfer facility nears capacity and priority is given to international traffic.

One cause for concern is the double-stack unit trains operated under the control of ocean carriers or multimodal companies. If such trains carried a mix of international and domestic containers into crowded on-dock facilities, the domestic containers would have to be drayed back out. But, true unit train operations are no longer the rule: almost all double-stack trains are broken up and reassembled as needed. Furthermore, much -- perhaps most -- domestic traffic carried under the auspices of ocean carriers or multimodal companies moves on a mix of trains and schedules separate from the dedicated trains scheduled to coincide with ship arrivals.

Beyond the overall volume of domestic intermodal traffic and the ability of railroad facilities to handle it, there is a question of control: who controls the routing and destination of domestic intermodal traffic, and can or will that party keep it out of crowded marine terminals and on-dock or port area transfer facilities?

Ultimately, the railroad customer controls selection of the railroad and the routing and destination of the traffic. Customers tender traffic at a specific point for movement to a specific point. A rail intermodal yard is a different point than an on-dock terminal in the same port city, and a steamship line would direct its traffic either to the intermodal yard, or to the marine terminal. The general answer to the question of control, then, is that both international and domestic traffic will be originated, routed, and terminated where the customer wants it.

Some rail customers, principally ocean carriers or their subsidiaries, tender both international and domestic traffic for movement via dedicated cars or a solid dedicated train. The loading and routing of dedicated trains or dedicated cars is, by definition, up to the customer, in this case the ocean carrier. To put it simply, if the ocean carrier wants to load or unload domestic containers under its control at on-dock or near-dock facilities, it will do so (as Maersk and Sea-Land presently do in Tacoma). If the containers are travelling on dedicated cars or in dedicated trains, the railroad will simply load, move, and unload the cars according to the customer's instructions. Traffic moving in common-user or other non-dedicated trains and cars, on the other hand, will be loaded, blocked, and unloaded in accordance with the railroad's preferences. Domestic movements would not be handled in on-dock facilities unless specifically directed by the customer.

In general terms, domestic container traffic, like all traffic, can be controlled by either the rail customer (a shipper or third party) or the railroad, depending on whether the rail customer chooses to exert control and on the terms under which the movement is made. Where the railroads can identify domestic movements and have choice, they can and will keep the bulk of such traffic out of on-dock facilities. Where an ocean carrier or third party controls the movement, and railroads cannot identify domestic movements, the rail customer and the traffic will follow economic and logistic incentives. It will be up to each port, and the operator of any on-dock transfer facilities, to ensure that incentives for rail customers to route domestic containers into marine facilities are not inadvertently created.

Minimal Domestic Port Impact. From the preceding discussion, it appears that the impact of domestic container traffic on port facilities will be minimal. The spectre of port congestion from domestic boxes has been raised, but this study located no reports of actual congestion from that source. Since ocean carriers, ports, railroads, marine terminal operators, and customers all have incentives to keep domestic containers out of the ports wherever congestion is likely, any influx of domestic containers in port facilities is likely to be small and sporadic unless local conditions encourage counter-intuitive routing practices.

Where there is only one intermodal yard in a city, the routing question is moot; the issue becomes the adequacy of that facility to handle both kinds of traffic. Where there is a choice of railroad facilities, the railroad is most likely to segregate traffic by handling type, i.e., trailers versus containers. BN makes this distinction in Seattle, CNW in Chicago, and SP in Los Angeles. Were substantial amounts of trailer traffic converted to containers, the railroad would more likely convert the trailer yard or add container-handling capability, rather than allow one facility to go under-used while the other is overburdened. Railroads have demonstrated their willingness to expand and change facilities as intermodal traffic itself expands and changes: witness CNW's plans for Global Two in Chicago, and SP's plans for expansion of the ICTF in Los Angeles.

Although port planners remain uneasy, we have found no reason to expect a substantial influx of domestic containers that would congest port-related facilities. The operational concern is how international containers will be brought to the marine terminals from mixed international and domestic double-stack trains. Where containers are drayed, there is no problem in sorting containers (other than occasional mixups). Where containers are brought by rail to on-dock terminals, railroads and their customers will have to cooperate in loading and blocking trains to facilitate separation at destination of those cars bound for the on-dock yard.

B. PORT ISSUES

1. Introduction

Increased ocean carrier control of international container routings to and from inland regions beyond the boundaries of the ports has irrevocably modified the traditional relationships between port authorities, ocean carriers, and railroads. Container ports are highly competitive, both between regions and within regions. Ports compete for vessel calls and for cargoes; they cannot create either. Thus, strategies intended to increase vessel calls and container cargoes can succeed only at the expense of other ports. An obstacle to one port or region is often an opportunity for another. Ports have little control over the two major factors that influence the routing of international intermodal containers through their terminals: the discretionary nature of international intermodal container movements; and the size of the local population that attracts both international and domestic cargoes.

Discretionary Container Movements. One of the most important characteristics of international intermodal container transportation is the discretion ocean carriers have in the routing of containers through U.S. coasts, coastal regions, and ports. Reportedly, discretionary flows amount to as much as 80 percent of the container traffic at some major intermodal ports, such as Seattle.

While ports have little control over discretionary container movements, they can influence a carrier's routing decision through development of state-of-the-art facilities (notably including intermodal rail access); through provision of ancillary services; and through increased cooperation with ocean and rail carriers -- but generally not through price cuts in basic port charges. Port charges are a decreasing share of a carrier's total costs, and they are of decreasing importance in a carrier's deployment decisions (except, perhaps, in choosing between adjacent ports in the same region).

Local Market. The size of a port's local market is a major consideration in a carrier's deployment of intermodal equipment. As their domestic business grew and became profitable in its own right, the intermodal ocean carriers expanded their domestic activities. Now, for the major participants, international and domestic operations have became so interwoven that those carriers must achieve an overall balance of domestic and international movements to avoid repositioning both empty containers and empty double-stack railcars. The large local population that leads ocean carriers to call at a port with oceanborne international containers also leads those same carriers to serve the port region with railborne domestic containers.

A change in the distribution practices of major U.S. importers, however, is causing a shift from local to intermodal traffic at West Coast ports. Until recently, up to 50 percent of the shipments imported by firms such as Sears and K-Mart were treated as local cargo. The containers were drayed to transloading facilities near the ports, especially in Southern California, and the goods were re-sorted into truck trailers for delivery to inland warehouses. Much of this traffic is now transloaded in Asia, moving thereafter via double-stack trains directly to inland distribution centers. This trend has contributed to the growth of eastbound double-stack import traffic over and above the actual growth in imports. From the ports' perspective, this traffic has changed from captive local cargo to discretionary intermodal cargo, which can now be routed without regard to the availability of local warehousing or transloading facilities.

2. Changing Port Roles

A generation ago, ports were faced with the conversion from break-bulk to container facilities. Now, their role has expanded from simply providing waterfront facilities to expediting container movements between ocean and domestic carriers (rail and truck) through the provision of intermodal container transfer facilities. These facilities are sometimes on-dock but they must be at least near dock for efficient and economic transfer.

Accommodating Future Containerships. It is not just the facility that has to be provided. As ship sizes increase to post-panamax dimensions to take advantage of economies of scale in order to reduce unit costs, all terminal functions are affected. The changes required in each function put pressure on ports for both capital and land -- and both are becoming scarce. There are five major issues facing ports in accommodating future containership operations:

1) berth size and number;
2) ship/apron transfer rate;
3) apron/storage transfer rate and storage capability;
4) storage/inland transfer rate; and
5) gate processing.

Every one of these issues represents a demand for capital, land, and management attention that conflicts with the equally pressing needs for container transfer facilities and related initiatives. The supply of land adjacent to deep water is very limited, and very desirable for other uses as well. Ports are facing demands for more on-dock rail facilities at the same time new marine terminals are growing to 40 or 50 acres. Capital, never plentiful, is being stretched thin by these intermodal requirements and in some cases by post-panamax ship operators who want up to four automated, dual-hoist container cranes per terminal at a cost of $7 million each.

The continuous decline in the actual number of major container operators, through bankruptcies, mergers and service rationalization, has placed a larger percentage of international cargoes into the hands of fewer carriers. The rationalization of ocean carrier services has evolved fewer, if larger, ocean carriers that require significant terminal capacity and intermodal access. For container ports competing for these carriers, this evolution offers fewer opportunities and greater risks: the participants in the market are fewer, but they require more investment in land, facilities and equipment. Moreover, the rise of discretionary cargoes, which can be handled at any of a number of container ports, puts heavy pressure on the competing ports to offer dedicated marine terminals, dedicated on-dock rail transfer, and other dedicated options at attractive rates, even before they have cargo commitments.

Facility Initiatives. Current intermodal container transfer facilities range from "on-dock" facilities in the marine terminal, to "near-dock" facilities within a short dray of the marine terminal, to "off-dock" facilities miles away from the terminal. In the off-dock scenario, the container typically passes from the ocean carrier's jurisdiction to a drayman (trucker's jurisdiction) at the marine terminal gate, and from the drayman to the railroad (railroad's jurisdiction) at the railyard gate. Two inspections are performed in this procedure, with two sets of documents and attendant delays. The objective of on-dock transfer is to reduce the cost, time, and administrative effort required to shift containers between the ship and the railcar. In the "on-dock" scenario, the container passes directly from the ocean carrier to the railroad, with only one inspection and only one set of paperwork. A port's ability to provide on-dock intermodal transfer can be a competitive advantage for discretionary cargo. On-dock container transfers now take place in Tacoma, Portland, San Francisco, Long Beach, Baltimore, and New York/New Jersey.

On-dock transfer: 1) reduces two interchange processes to one simplified procedure; 2) avoids the use of highway licensed and equipped drayage equipment; and 3) avoids highway weight limits, which prevent containers from being loaded to their full weight capacities. This last feature may merely shift the problem inland if containers that exceed highway weight limits are to be moved over the road from railyards to their ultimate destination.

On-dock transfer, therefore, is not a technological or operational innovation, but an organizational and institutional one. There are other ways in which most of the benefits of on-dock transfer can be obtained: public highway easements, streamlined paperwork and administration, and simplified work rules. In some cases, such accommodations make "near-dock" the practical equivalent of "on-dock."

Labor jurisdiction may be a serious institutional issue for some on-dock initiatives. Simply put, will on-dock rail transfer facilities be operated by marine union (longshore) labor, rail union labor, other union labor, or non-union labor? The problem is real and can be serious: the opening of Baltimore's Seagirt on-dock facility was delayed by labor jurisdiction disputes.

There have been several significant recent port facility initiatives ranging from on-dock transfers to remote inland terminals. Each of these projects represents an effort on the part of the port to attract a share of the discretionary cargo market, and all of these projects represent a new and more aggressive role for ports.

Port Roles in Domestic Containerization. Ports will not have significant roles in domestic containerization, or in the development of domestic double-stack networks. In fact, ports appear prepared to resist any such role, and to reserve their resources for waterborne trade. The involvement of ports in domestic container movements, if any, will be incidental to international movements. It is possible, for example, that a port acting as a shipper agent might coordinate a domestic backhaul for an ocean carrier client, but such activities would likely be sporadic.

The role of ports may change because of domestic containerization. If the rail facilities now serving both international and domestic traffic cannot be expanded to handle the growing volumes of both, ports may be induced to provide, or participate in joint ventures to provide, new facilities dedicated to international traffic. The ICTF in Los Angeles is a prime example of a joint venture between the Ports of Los Angeles and Long Beach and Southern Pacific.

3. Port Issues

Increased Port Competition. The advent and growth of double-stack container services has created new forms of competition between ports, and extended port competition into new markets. Historically, the East Coast, West Coast, Gulf Coast, and Great Lakes regions were considered separate markets, with little competition between ports on different coasts. Ports competed almost exclusively with other ports serving the same hinterland or local service area. Since well defined hinterlands did not extend far inland, such competition tended to be intra-regional rather than inter-regional.

Until the advent of inland intermodal services, which can be dated roughly by the introduction of MLB (mini-land bridge) tariffs in 1972, neither ports nor their ocean carrier clients had much control or even influence over container transportation beyond port boundaries. Inland transportation for both imports and exports was typically arranged by the shipper, the consignee, or a third party. Under those circumstances, ports had neither means nor incentives to compete for cargo beyond their immediate hinterland.

The increased participation of ocean carriers in inland transportation, accelerated by the introduction of double-stack services, brought aggressive inter-regional port competition. Boston, New York, Philadelphia, Baltimore, and Norfolk can all compete for a container shipment between Europe and the Midwest. The same development placed ports on different coasts in competition: Los Angeles can compete with New Orleans for a container shipment between Asia and Memphis, for example, and it can compete with New York for a shipment between Asia and Pittsburgh.

The growth of international container traffic, by itself, is expected to engender regular double-stack service to additional inland points. Domestic container traffic will further increase the number of double-stack hubs. The combined effect will be to extend the competitive hinterland for major ports, and raise the stakes in both inter-regional and intra-regional port competition. Ports will effectively have <u>two</u> hinterlands: a local region in which they compete with neighboring ports; and an extended inland region, nearly national in scope, in which they compete with most major container ports.

The extended inland reach of the major ocean carriers, including carriage of their own traffic and third-party carriage of other carriers' traffic, will further concentrate control over routing decisions on both the water and land sides of the ports. The resulting market power and bargaining leverage of the major ocean carriers has already shifted, and will increasingly shift, the primary goals of port competition toward obtaining long-term commitments from these carriers and encouraging them, through port investments in non-traditional facilities and services, to route as much traffic as possible through the port. As more inland traffic comes under ocean carrier control, the stakes in that competition will increase: the loss of a port client will be more severe, the gain of a new client more beneficial. At the same time, ports face additional demands on their finite financial and land resources.

Increasing competition between ports will draw many port strategies toward a more active operating role, away from the "landlord" style of port development. Landlord ports typically develop facilities but do not participate in terminal operations or offer much in the way of ancillary services. Formerly, "operating ports" were narrowly defined as those that provided stevedoring services at their terminals. The current emphasis for operating ports, however, is not on terminal operations (which are increasingly the province of ocean carriers), but on ancillary services of all kinds.

One major ancillary service directly related to the expansion of double-stack services is the provision of a neutral chassis pool. By replacing several ocean carrier and terminal pools with one centralized operation, a neutral chassis pool is intended to increase chassis utilization and to reduce cost and congestion. The Ports of New York, Baltimore, Charleston, Jacksonville, and Portland, Oregon, have recently established neutral chassis pools. Neutral chassis pools are growing in popularity at ports, multi-user terminals, and rail facilities, and may become the norm for all but the largest ocean carriers.

Numerous ports and regional port groups are working to create local or regional cargo release systems to interface with automated systems being implemented by the Customs Service. One program of note is the Regional Automated Cargo Expediting and Release System (RACERS) being developed by the Golden Gate Ports Association. With partial sponsorship from MARAD, RACERS will become not only a working electronic interface between Bay Area ports, carriers, brokers and Customs, but also a generic template for development and implementation of such systems at other U.S. ports.

Major competitive strategies by container ports are likely to require innovation and expenditure well beyond the previous scale of competition. The Virginia Inland Port is a dramatic example, as the Virginia Ports Authority has built an "upstream" intermodal satellite facility to attract discretionary traffic from the local hinterland of competing ports.

Rail Access and Container Transfer Facilities. If there is one potential obstacle to obtaining port benefits from the growing double-stack network, it is rail access and associated container transfer facilities. Rail access for containers was rarely considered before the advent of discretionary intermodal container cargoes. Now, rail access is an important competitive issue. Container ports have found their roles evolving to include facilitation of intermodal transfer in order to improve or maintain their competitive positions. Only a few ports were fortunate enough to have rail access on or near their container terminals. In most cases, new or improved intermodal container transfer facilities at or near the ports were necessary for efficient and economic intermodal container transfer.

The ideal situation, from the ports' point of view, is to have direct, unimpeded services from two or more major competing railroads with on-dock or near-dock facilities adequate for future growth, frequent arrivals and departures, and line clearances for double-stacked high-cube containers. Railroads, of course, prefer exclusive access, resist building excess capacity, schedule trains to suit the traffic, and invest in increased line clearances only when justified by potential revenues.

The vast differences in the physical characteristics of ports, railroads, and port cities virtually guarantee that each port will face different circumstances, with different institutional and operational barriers to be overcome. On-dock (or at least near-dock) rail facilities figure prominently in the strategies of most major container ports. Unlike the relatively standardized double-stack trains themselves, there will be no standardized on-dock rail facilities. The right solution for one port may resemble the right solution for another port only in principle and function.

Rail access also has a vertical dimension: line clearance. Double-stack cars carrying two high-cube containers require about 20 feet of clearance over the rails. In many places, particularly in railroad tunnels and in the infrastructure of older cities such as Boston, rail lines leading to major ports do not have adequate clearances. Correcting these problems is costly, and the railroads cannot always justify the expense for the potential incremental traffic. So far, only one port, the Port of Oakland, has actually participated in funding tunnel clearance improvements. The Port of San Francisco has agreed to participate in planned tunnel improvements on the SP line serving the port. East Coast ports face greater obstacles to resolving such clearance problems, since clearance problems are much more pervasive in the area between East Coast ports and the eastern rail network. The State of Pennsylvania has reportedly approved some $32 million to support tunnel clearance improvements for the Ports of Philadelphia, Pittsburgh and Erie. High-cube containers are not yet common in the transatlantic trade, but more East Coast ports may have to follow Oakland's example in the future.

The prospect of legislative or regulatory action on rail access has been raised, akin to proposals for "competitive access" amendments to the Staggers Act. The American Association of Port Authorities, in its comments to DOT regarding national transportation policy, argued for a federal role in creating intermodal corridors through urban areas. It is not clear that rail access for on-dock facilities is universally necessary. The Department of Transportation has recently established an interagency working group to address the rail access problem.

"Port Trains". One result of the expansion of the double-stack network will be a reduced perceived need for "port trains." The initial phase of double-stack service was dominated by the dedicated trains of a few major carriers at a few major ports, leading to concerns over the fate of smaller carriers and smaller ports. This concern, in turn, led to proposals for "port trains": regular double-stack services with ports providing volume commitments and marketing efforts. There were several proposals for such operations, and a few short-lived trials.

On-going developments, particularly the expansion of the double-stack network, will effectively eliminate any long-term role for the ports in initiating double-stack services. The ports should therefore be able to avoid competing with their own tenants whose subsidiaries also solicit the traffic of smaller carriers. Equally important, the financial and managerial resources of the ports can be reserved to meet other pressing needs.

In the short term, there may still be a role for port-sponsored projects to demonstrate the viability of common-user trains, especially where some railroad resistance remains, and to attract additional containers to new double-stack services. Although it is not clear that it was planned that way, the proposal by the Port of Seattle to sponsor trains was unquestionably effective in encouraging BN to start common-user trains. Whether such a strategy would be effective, or even necessary, to promote common-user services at other ports would depend on the individual circumstances.

Development Impediments. Ports are faced with a continuous need to expand and upgrade their facilities. Being public agencies and working in a highly visible social and political arena, they encounter more obstacles to intermodal development than either ocean carriers or railroads. There are three major obstacles to port intermodal development, none of which is unique to the intermodal function: (1) limited fiscal or physical resources; (2) lengthy and expensive approval processes; and (3) competing demands for increasingly expensive facilities.

A port, in its most literal sense, is a collection of facilities for the exchange of cargo between sea and land. But a port, in the modern context, has become a high-tech, multi-commodity, multi-modal operator; a real-estate and recreation manager; a tool for regional development; and a focal point for environmental concerns. Each of these roles requires money and land, and there is not enough of either. The public backing of ports to fulfill traditional community objectives, such as providing employment or facilities to support local exports, has diminished, yet the public expectations regarding the objectives have not diminished. Today, ports are increasingly expected to turn a profit on a commercial basis.

Technological advances and inflationary pressures have increased equipment prices significantly, and ports are expected to finance expansion of their infrastructures beyond the wharf gate to include intermodal facilities. To accommodate this growth, ports are turning more to long-term contracts with ocean carriers to fix and guarantee revenue streams for existing or newly developed marine terminals. This approach, however, tends to lead to the development of dedicated marine terminals, thereby exacerbating the problem of allocating limited physical resources.

Ocean carriers are forming their own stevedoring subsidiaries to operate their own terminals. More and more, these carriers will want exclusive terminals under their own control, and they will be willing to pay for them. Most terminals will be on long-term lease to major container operators, with third-tier operators being secondary users of the terminals.

In order to keep up with the demand for marine terminal acreage, assuming adequate financing has been secured, ports are upgrading existing facilities or creating new land by landfill. In this era of high environmental awareness and public participation, the development cycle can take as long as seven years from project concept to implementation. That time frame is simply unacceptable for carriers introducing or expanding intermodal operations.

Competing Demands. Besides trying to provide efficient rail transfer facilities, ports must continue to build and improve their marine terminals, the equipment and operations within the terminals, and other projects demanded by port clients or by political constituencies. Double-stack operations account for only a part of containerized foreign trade, and containerized trade accounts for only a part of the import and export cargoes ports must accommodate. All of the pressures for facilities lead to a shortage of both capital and land at most major ports. Indeed, the shortage of land aggravates the capital problem, as the cost of adding land increases. The escalation in container ship size and cost increases the pressure on terminal operators to turn those ships rapidly, and increases the pressure on ports to provide the latest, fastest, and most expensive terminal equipment. Commodity-specific developments in transportation and distribution usually add to the demands placed on the ports. Land along the waterfronts of major cities is scarce and expensive, and there are many competing uses. Ports are under ongoing revenue pressures, and their own non-cargo developments often yield more revenue than marine terminals.

European Cargoes. Much of the transpacific Asian trade formerly handled at East Coast and Gulf Coast ports has shifted to the West Coast. There has not yet been a comparable shift of European cargoes to the East Coast: substantial volumes are still carried in all-water services to the West Coast. As the double-stack network expands, it is highly likely that much of the container traffic between Europe and the West Coast will shift to MLB rail services, and be handled through East Coast ports.

Much of the demand for European imports lies east of the Mississippi, where the distances from East Coast ports are often too short for efficient stack-train service, and the volumes are not sufficiently concentrated. The traffic data developed in this study suggest that it would be difficult for individual ocean carriers to generate full stack trains of European cargo to individual cities west of the Mississippi. Even though the majority of the estimated total annual imports to California through Northeast ports of 24,000 FEU (not just European) -- or the equivalent of three 15-car stack-trains per week -- is bound to the Los Angeles Basin, one ocean carrier would need a very large market share to bring enough traffic under single control for a weekly train.

Westbound carriage by stack-train operators who are otherwise oriented towards eastbound Asian traffic may provide the means to convert European cargoes to MLB. Full trainloads would not be required, nor would all the containers have to share a single major destination, since stack trains from the East Coast return to all the West Coast ports several times per week with a mix of international, domestic, and empty containers. Three transpacific MLB operators, APL, "K" Line, and Sea-Land (which also operates in the Atlantic), have established their own East Coast rail facilities in New Jersey to handle stack trains. Through subsidiaries, these stack-train operators (and others, without their own yards) solicit westbound traffic that could include European cargoes bound for the West Coast.

There is one important obstacle: European cargoes could not serve as backhauls to balance Asian imports. Empty containers from Asian imports might accumulate in the Eastern states waiting for backhaul cargo, while European import containers would arrive from transatlantic carriers.

Operators such as Sea-Land, Maersk, and Evergreen, who operate in both trades, may be able to achieve some world-wide balancing. But for the most part, the transatlantic container flows would be separate from the transpacific.

The integration of European cargoes into domestic container flows may prove to be a solution. Indeed, for stack-train operators such as API or Rail-Bridge, a movement from their New Jersey terminal to a Midwest or West Coast city would effectively be a domestic shipment, albeit in an international container that may have to return to the East Coast.

4. Issues for Gulf Coast and Great Lakes Ports

The issues described above concern primarily the East Coast and West Coast ports, which have had the largest increases in intermodal container traffic and the greatest need to cope with it. Some of those increases have come at the expense of Gulf and Great Lakes ports, where former all-water services have been dropped in favor of MLB moves. While the Gulf and Great Lakes ports face many of the same issues -- port competition, rail access, competing demands, etc. -- on the container traffic they still carry, they also face other issues relating to their market and how it will be served.

The Gulf and Florida ports, particularly Houston, New Orleans, Tampa, and Miami, are looking to Latin American, African, Caribbean, and Mediterranean trades for their long-term market niche. The major issue facing the Gulf ports is whether they will be significant participants in the combined international and domestic double-stack network. There are several obstacles to their participation. First, while there are numerous double-stack services between Houston or New Orleans and the East and West Coasts, there are as yet few north-south services connecting the Gulf ports with Midwestern markets. Among the few is a double-stack movement of coffee beans from Houston to Kansas City via Kansas City Southern. Second, substantial portions of Gulf general cargoes are not yet containerized, and most are carried on Ro-Ro, breakbulk, or refrigerated vessels. Although it is conceivable that some of these cargoes could be stuffed into domestic containers rather than truck trailers for the trip inland, it seems more likely that these cargoes will become intermodal only after they are routinely containerized at origin. Third, a relatively large fraction of the Gulf inbound container cargoes, especially bananas and other fruits, are refrigerated. Double-stack movement of these cargoes is not yet practical, as there are only a few stack cars capable of supplying power to refrigerated containers. Fourth, distances from Gulf ports to Midwestern markets are relatively short, near the minimum distance for the most efficient possible double-stack trains. Thus, movements to those cities are more difficult to convert from truck to rail. Fifth, as shown below, Gulf Coast traffic volumes to regions other than the Lower Midwest are low relative to that required for double-stack trains.

1987 Container Volumes
Through Lower Midwest/Gulf Ports

Gulf Ports To/From	Import FEU	Export FEU
California	7,021	26,715
Northwest	842	2,330
Mountain States	3,088	21,820
Upper Midwest	9,933	21,614
Northeast	30,203	13,929
Mid-Atlantic	2,191	21,466
Lower Midwest	37,234	132,296

Source: Task IV Report, Appendix IV D.

The fourth and fifth obstacles may be easier to overcome as the influx of domestic containers makes intermodal container service between the Gulf and Midwest more feasible. Just as increased service frequency and broader coverage are expected to benefit smaller transatlantic and transpacific ocean carriers, they can be expected to benefit Gulf ports and carriers whose present container volumes are neither large enough nor concentrated enough to justify dedicated train service. Although provision of more double-stack services to the Gulf would encourage the further containerization of Gulf trades, there are too many other factors to conclude that more train service would be decisive.

Container traffic at the Great Lakes ports has never been substantial, and it is unlikely to become a major force in the future. First, the navigation locks in the St. Lawrence Seaway prohibit the use of modern, wider container ships, and the longer voyage to Great Lakes ports would negate some of the advantages of landbridge movement. A second factor limiting Great Lakes container activity is the annual closure of the St. Lawrence Seaway. In April and May of 1989, The St. Lawrence Seaway Development Corp. participated in meetings regarding intermodal rail service during the winter closure. The general idea is that double-stack trains could ferry containers from open East Coast ports to the Great Lakes ports, a true minilandbridge movement. If an efficient service could be developed, it would allow use of Great Lakes port facilities twelve months a year, significantly improve utilization, and reduce unit costs. The Port of Quebec has reportedly investigated similar alternatives, as has at least one terminal operator at the Port of Chicago.

C. OCEAN CARRIER ISSUES

1. Different Implications

The largest ocean carriers are carrying more of the transpacific cargoes, and are committed to intermodalism. Many smaller carriers, however, have yet to make that commitment. The implications of domestic double-stack service are different for each group. The intermodal ocean carriers view domestic container traffic as a new market, with its own revenue potential but also with significant impact on existing markets. Domestic containerization allows these carriers to expand their double-stack networks, which in turn generates new opportunities for efficient carriage of both domestic and international containers. Smaller container carriers with limited or no intermodal operations have neither the organization nor the capital to compete in the domestic market, the benefits of domestic containerization that accrue to the smaller carriers are mostly indirect, though potentially considerable. The increase in double-stack departures from the smaller carriers' port cities, by intermodal operators or railroads responding to the domestic market, allows these carriers to increase the scope of their international intermodal business without the need for significant organizational change or capital investment in intermodal operations.

The issues raised by double-stack domestic operations are somewhat different for the ocean carriers than for the ports. This is not to say that some issues, such as the development impediments faced by the ports, do not also affect the carriers. Some issues, however, are more specific to the carriers.

2. Changing Ocean Carrier Roles

Expanded Responsibilities. Before containerization, carriers generally accepted cargo at the pier, loaded the cargo aboard ship, sailed the ship to another port, discharged the cargo, and, finally, turned the cargo over to the consignee or his agent at the pier. The initial stages of containerization expanded the scope of services provided by the ocean carrier to include local pickup and delivery and container stuffing/unstuffing of less than and full container load shipments at off-terminal container freight stations (CFS). Today, the ocean carrier role is significantly expanded. Carriers now offer single-factor rates between foreign and domestic inland points. Accordingly, ocean carriers must provide: rail transport to/from the principle rail hubs throughout the country; long distance trucking between the principle rail hubs and customers located in secondary cities; load pick-up and delivery as well as consolidation (CFS) services at major points; and container and chassis pools throughout the country. Ocean carrier marketing efforts are now spread throughout the country. The marketing staffs are not only soliciting international cargoes but domestic cargoes as well -- either directly or through a subsidiary -- to maximize equipment utilization. The scope of management responsibilities has increased almost geometrically with the increase in services. Equipment control systems, for example, must now be able to cope with the fact that perhaps a half a dozen land carriers will be responsible for a given container before it is returned to the carrier.

The degree of participation in intermodal service varies significantly throughout the country. Some of the larger participants have established large multimodal companies; other participants depend on agents of some sort -- ports and railroads, as well as the more traditional third party agents.

Future Role. How will the ocean carrier's role change in the future? Intermodal operations will expand to the point where the major carriers serving the United States will be able to carry, on a single bill of lading, international cargo to and from any inland point. The carrier will also be heavily involved in the carriage of domestic goods in order to maximize the efficiency of their international operations. Management responsibilities will continue to expand with the expansion of services.

The North American subsidiaries and affiliates of major ocean carriers are likely to maintain their major role in domestic containerization, while the ocean carriers themselves concentrate on international movements. The growing volume of domestic business has led numerous ocean carriers to establish subsidiaries or affiliates with separate management structures and profit centers. Those that contract for double-stack service and let third parties market the service will only be passive providers of containers, however large the volume. Those that take a more direct role in operating and marketing double-stack services are more likely to enter the ranks of multi-modals.

Increased Carrier Competition. The advent of inland intermodal service has increased, and will continue to increase, the scope of ocean carrier competition. The economic benefits of balanced double-stack movements have led the carriers to compete just as fiercely for domestic backhauls, either through subsidiaries or by making their container capacity available to railroads or third-party agents.

As international container flows increase and domestic container flows are added to the double-stack network, that network will expand in two ways. First, improvements in service frequency and market access will broaden and intensify the competition among ocean carriers or ocean carrier subsidiaries. As smaller carriers gain access to the double-stack network through common-user trains, their containers will increase the total capacity available for domestic loads, and they will become direct rather than indirect competitors. Second, The increased availability of common-user and third-party services to more inland hubs will be of particular value to smaller ocean carriers. The common-user trains and the third-party activities of major intermodal operators such as API and CSL allow smaller carriers to negotiate for favorable rates based on their full annual intermodal volume, rather than on their volume in just one corridor. Reportedly, railroads and third parties have offered contract rates for as little as 1,000 annual units (although such rates would not be as low as those for greater volumes).

It is important to note that even large steamship lines are "smaller carriers" in secondary corridors. With the added volume of domestic containers, regular double-stack service may be offered to hubs not now served by dedicated ocean carrier trains. Further integration of double-stack operations into the railroad network is likely to result in service to intermediate points between the largest hubs.

Technology spreads rapidly in the intermodal field. Suppliers and operators are quick to incorporate successful innovations in their own products and systems. The focus of competition is therefore likely to shift to customer service and provision of high-quality, door-to-door transportation. Any enduring market advantage must be based on some factor that is not easily imitated and cannot be leased on short notice with minimal capital investment. What might be called "management technology" -- knowledgeable managers, information systems, customer communications, quality controls, etc. -- cannot be bought off the shelf; nor for that matter, can a reputation for high customer service. Leading intermodal firms have reorganized frequently in the last few years in an attempt to adapt existing organizational forms and personnel to a new and highly competitive endeavor.

<u>Increased Market Concentration</u>. The increased competition between carriers and the greater emphasis on service quality will work to the advantage of the large intermodal operators, who can control door-to-door movements across the country. That control, and the provision of consis-

tent, high-quality service, requires substantial financial resources and a large revenue base, both of which will likely be beyond the reach of medium-sized ocean carriers. The big ocean carriers will get bigger. The smaller ocean carriers will find it easier to use the services of the intermodals, railroads, or third parties.

In an increasingly competitive intermodal market, ocean carriers will be faced with a choice between making a full-scale commitment to international and domestic intermodal operations, or becoming a customer of the larger intermodals who have made that commitment. As the scale of commitment grows, the industry will tend to bifurcate, and those companies with a medium commitment to intermodal operations may be squeezed out.

Reduced competitiveness of ISO containers. The 40- or 45-foot ISO container will face a serious challenge from the 48-foot 102-inch domestic container in domestic markets. The 48-foot domestic box offers 13 percent more cubic feet than its 45-foot ISO counterpart, and 28 percent more than the 40-foot ISO box (assuming all are high-cube containers). Not every domestic commodity requires the extra space, but many shippers can make use of it, and few if any would reject a box for being too large.

As 48-foot, 102-inch high-cube domestic containers become more commonly available, ocean carriers will either have to offer discounts for smaller ISO containers or somehow market them to shippers of heavier goods. ISO boxes may even be at some disadvantage when it comes to heavier goods, because a steel 45-foot ISO high-cube container (up to 10,140 lbs.) outweighs an aluminum 48-foot domestic container (8,100 lbs.), thus offering reduced weight capacity as well as reduced cube capacity.

Overweight Containers. The problem of overweight containers is likely to affect ocean carriers and their intermodal subsidiaries more than it will affect railroads or ports. Ocean carriers or their intermodal subsidiaries are generally the parties who accept loaded containers from the actual shippers, and who are in a position to check container weight and enforce weight limits. With regulatory and legislative efforts to narrow responsibility for overweight containers now being considered, it appears that ocean carriers may find an enforcement role thrust on them if they do not perform it willingly.

Several regulatory or legislative approaches to the overweight problem have been proposed:

- holding overweight import containers at the terminal, just as is done for those owing Customs duties;
- weighing all import containers before releasing them to truckers;
- reducing the issuance of special permits for overweight boxes;
- changing tariffs to weight-based rates within highway limits; and
- standardization and simplification of weight and length limits and formulas.

The first two proposals would not deal with overweight export containers, which, as FHWA's March 1989 report demonstrates, are a large part of the problem. The last proposal may make compliance easier, but does not directly force compliance. The remaining suggestions would both affect ocean carrier operations and marketing.

Fleet Capacity and Price Pressure. The first few years of double-stack service were characterized by aggressive pricing to secure domestic backhauls. The operating economies of double-stacks were widely discussed in industry publications, and often overstated. As a result, domestic shippers were led to expect a substantial discount on double-stack container movements, not only below truck rates but below piggyback rates as well. Shippers and third-party agents are wooed by numerous ocean carriers, intermodal subsidiaries, and railroads. The former backhaul discount has become the market price, much to the chagrin of intermodal companies seeking to establish a fairly priced, profitable, premium service.

Some industry observers have predicted overall excess capacity in the double-stack fleet in the near future. Excess capacity throughout the system, should it develop and persist, would seriously reduce double-stack profitability, which many see as marginal already. It would exacerbate the long-standing practice of discounting westbound domestic movements, and it could lead to a rate war on traffic in both directions. Only a few ocean carriers subsidiaries have any financial obligations for the intermodal equipment, and such obligations account for only a small part of the fleet. The direct effect of decreased utilization might therefore be felt more by the railroads and Trailer Train than by the ocean carriers.

VII. THE INTERMODAL INDUSTRY AND DOMESTIC CONTAINERIZATION

A. OVERVIEW

The future of double-stack container services, both domestic and international, depends on much more than technological developments and cost comparisons. The greatest challenges to the the emerging intermodal industry are not likely to be technical or economic, but managerial and institutional.

If the intermodal industry can meet those challenges, the rewards will be substantial. Intermodal traffic is the fastest growing segment of the railroad industry. Double-stack technology holds the potential to handle this growth more efficiently and profitably than conventional systems. The largest source of growth, however, is the vast amount of intercity freight traffic moving by truck. In Task II, it was estimated that up to 3.2 million annual truckloads would be divertible to a nation-wide double-stack network under favorable assumptions.

If it is to succeed, large-scale domestic double-stack container service must prosper in a shipping community whose standard of service is the motor carrier. According to NMTDB and ICC data compiled by the AAR, intermodal service accounts for only 15-16 percent of the domestic traffic moving over 500 miles (exclusive of private carriage and team drivers). Intermodal service now accounts for up to 70 percent of those markets in which it is most successful (i.e., dry van truckload traffic between major cities more than 700 miles apart). Nonetheless, much of the shipping community remains openly skeptical of intermodal service. To reach its full potential, domestic double-stack service will have to offer customers more than just cheaper piggyback.

B. THE RELATIONSHIP BETWEEN PORTS, OCEAN CARRIERS, AND RAILROADS

The Emerging Need For Cooperation. Until the recent growth in intermodalism, there was little need for close, three-way cooperation between ports, ocean carriers, and railroads. Three factors have intensified the need for cooperation between ports, ocean carriers, and railroads. The first factor is the discretionary nature of inland container cargo, which has increased competition between ports and between railroads. The second factor is deregulation, specifically the increased use of multi-year contracts that enable ocean carriers and railroads to make long-term commitments to container services. The third factor is increased competition within the intermodal industry, which has increased the pressure on all three parties.

The routing of container cargo bound to or from rail-served inland destinations has become discretionary because intermodal operations can move cargo efficiently to major inland points from more than one competing port, and because extension of ocean carrier services inland has shifted routing responsibility from ocean shipper to ocean carrier. Ocean carriers in the transpacific trade can reach mid-continent gateways and hubs such as Chicago, Kansas City, St. Louis, or Memphis with competitive cost and service from any major West Coast port. Ocean carriers in the Atlantic trades can do the same from several East Coast ports. This ability gives ocean carriers the flexibility to shift between competing ports to take advantage of better intermodal facilities, lower transfer costs, or a better price/service offer from a different railroad. This flexibility in turn places the ports, and the railroads that serve them, in more intense competition than ever before.

Deregulation and regulatory exemption of intermodal traffic have had numerous effects, but perhaps the most relevant change is the shift from published tariffs to negotiated contracts. The use of contracts rather than tariffs allows ocean carriers and railroads to enter into multi-year commitments regarding volume, rates, and service. Once such a commitment is in place, both parties can make plans and investments to handle a specific minimum volume of traffic tendered at a specific port. Conversely, competitive contract offers may depend on plans for cost-saving operations or investments. In either case, the contract commitment directs traffic through a specific port for a period of up to five years, and may require the cooperation of that port for success.

The factors described above, and others as well, have intensified competition on land, at sea, and between ports. Third-party intermodal participation has also tended to intensify competition, because third parties themselves are highly competitive and often have sufficient traffic volume to negotiate favorable contracts. In the container trades, recent large increases in capacity have given ocean carriers incentives for aggressive pricing. Changes in the conference system, notably the increased latitude for "independent action", have brought much the same competitive pressure on the sea as deregulation has on land. Load centering, the practice of funnelling vast local and inland traffic through a small number of container ports, has raised the stakes in port competition.

<u>The Ocean Carrier-Railroad Relationship</u>. The major interchanges of traffic between ocean carriers and railroads are confined to contractual relationships. Ocean carrier-railroad contracts can take several forms, the first of which is a dedicated double-stack train operation, the form in which double-stack operations were popularized. In such a contract, the railroad operates a double-stack train on a fixed route for the exclusive use of the ocean carrier. This is often a "take or pay" contract: the ocean carrier pays for the round-trip railcar movement, whether or not there are any containers aboard. A second contract type dedicates a number of cars for use of the ocean carrier, but they operate as part of a regularly scheduled train rather than as a dedicated train by themselves. This type of contract is relatively uncommon, as it has been largely superceded by "common user" volume contracts. The third and perhaps most numerous type of contract is the "common user" volume agreement. In such a contract, the ocean carrier agrees to ship a minimum annual volume of containers over the railroad in exchange for favorable rates. The low rates are typically offered in corridors where common-user double-stack trains are operated, although in some cases the commitment is system-wide. It is critical to note that the low rates are based on the expected use of double-stack cars, but in lesser corridors or where double-stack cars are in short supply, the containers may actually move on conventional equipment.

The Railroad-Port Relationship. The railroad-port relationship centers around facilities and infrastructure. The issue of rail transfer facilities became germane for intermodal business as competitive pressures led ocean carriers and railroads to seek transfer cost savings. The elimination of over-the-road drayage through the provision of "on-dock" transfer facilities can confer a competitive advantage to the railroad-port-ocean carrier combination, and force competing carrier and port combinations to seek comparable improvements. The issue, however, is not as simple as "on-dock" versus "off-dock." Each major container port has a unique configuration of terminals and rail facilities. While there is a trend toward more on-dock facilities, several ports have examined alternatives designed to reduce transfer costs between existing facilities.

Ports would prefer to be served directly by several railroads, in order to offer their clients the benefits of rail competition. Each port, however, would prefer that the railroads serving it would not also serve other ports or solicit traffic at other ports. The railroads have opposing preferences: to serve as many ports as possible, and to be the only railroad at each. It is therefore to be expected that proposals to provide competitive port access to additional railroads would be supported by the port and the new railroad, and opposed by other ports and the existing railroad.

The Ocean Carrier-Port Relationship. As explained above, inland intermodal cargo is fundamentally discretionary, giving ocean carriers substantial freedom in the choice of a principal intermodal port. This freedom has fueled greater competition between ports in different regions, as well as between ports in the same region. As the number of large ocean carriers is reduced by merger, service rationalizations, and joint ventures, each remaining carrier acquires greater importance. Moreover, the nature of discretionary cargo and the competitive efforts of neighboring ports make a carrier's threat to switch ports very credible. To remain competitive, ports are compelled to invest in container cranes, terminal improvements, electronic gates and information systems, and on-dock or near-dock rail transfer facilities. Ports seek multi-year ocean carrier commitments to secure these investments.

Ports can be roughly classified as "landlord" ports (those that build and equip terminals but leave the actual operation to tenants) or "operating" ports (those that operate terminals with port employees). The distinction between landlord and operating ports, never sharp, is now breaking down further as ports take on additional service functions. Several major ports have shipper's agent authority, and can consolidate ocean carrier volumes under a rail contract rate. Virtually all major container ports are operating or developing automated cargo clearance systems in conjunction with the Customs Service. Several container ports also operate or lease port-area consolidation or distribution facilities to attract major importers, exporters, and their cargo. Finally, major intermodal projects underway or in development are typically multi-user facilities designed to capture economies of scale, and typically anticipate a higher level of port operating involvement than the historical pattern of single-user terminals.

Railroad Clearances. One current issue that unites all three parties is the issue of railroad line clearances. Double-stack cars require greater overhead clearances, and greater width at those heights, than other types of railroad freight cars, and there are many rail routes where tunnels, bridges, overpasses, or other structures do not have sufficient clearance. The problem is more common in the eastern states, where the older rail and road infrastructure has for many years limited the use of conventional piggyback cars and tri-level autoracks. The problem reaches its greatest dimensions when 53-feet long, 102-inch-wide domestic containers are placed on top, increasing the lateral clearance requirements at the greatest height. Few railroad tunnels were built with such clearances, and potential clearance problems with the largest domestic containers are common throughout the rail system.

Ocean carriers, railroads, and ports have a common interest in improved clearances and unrestricted double-stack access. The situation, however, is often described as a chicken-and-egg problem: railroads are generally willing to invest in clearance improvements if traffic to justify that investment is committed, but ocean carriers are unwilling to commit traffic unless clearances are improved. In at least one case, a railroad, an ocean carrier, and a port have jointly funded tunnel clearance improvements: Union Pacific, American President, and the Port of Oakland are jointly funding tunnel-clearance improvements in the Feather River Canyon. This cooperative action has encouraged other railroads and ports to explore the possibilities of joint endeavors, and at least two similar projects are currently under consideration.

C. TRENDS IN MULTIMODAL OWNERSHIP

1. Multimodal Versus Intermodal

Within the intermodal environment is a small, but growing number of "multimodal" companies. The critical feature that sets multimodal companies apart from single-mode companies is their operating responsibility for more parts of the intermodal movement than heretofore typical of steamship lines, railroads, or third parties. Ownership of assets in more than one mode does not necessarily yield multimodal transportation, nor does multimodal ownership necessarily yield "one-stop shopping" or "total transportation."

The crucial issue is management and coordination. Multimodal ownership is not the unique answer to the problem of coordinating intermodal functions. If managed well, multimodals would indeed be highly competitive. If not managed well, multimodals may lose in flexibility more than they gain in coordination.

2. Multimodal Companies

American President Companies (APC). The first ocean carrier to make the commitment to become a multimodal transportation company was American President Lines. In 1983, as part of the merger agreement between the Natomas Company and the Diamond Shamrock Corporation, APL became part of a publicly traded corporation known as American President Companies. APC acquired its own shipper's agent, National Piggyback Service, from the Brae Corporation in 1985. American President Intermodal (API) was formed in 1985 to operate the double-stack train network. Early in 1987, American President Domestic (APD) was established as a peer to American President Lines (APL) to provide overall management of domestic transportation services. National Piggyback, renamed American President Distribution Services (APDS); Intermodal Brokerage Services, renamed American President Automotive Distribution (APAD); and API were all placed under APD. The recent formation of American President Trucking (APT) has given APC an operational footing in the highway mode and spurred the creation of "Red Eagle" dor-to-door service.

CSL Intermodal (CSL). CSX/Sea-Land Intermodal came into being through acquisition and merger. The CSX portion of the name is the result of a merger between the Chessie System railroad and the Seaboard Coast Line in 1980. The Sea-Land portion came through the acquisition by CSX of Sea-Land in 1987.

Prior to acquiring Sea-Land, CSX Corporation had split the railroad into three quasi-autonomous functional groups under CSX Transportation: CSX Distribution Services to handle marketing, CSX Rail Transport for operations, and CSX Equipment to manage rolling stock. All of CSX Distribution Services' intermodal activities (which were an amalgamation of Chessie's and Seaboard's intermodal operations) and Sea-Land's inland intermodal services group were brought together in January, 1988 as CSX/Sea-Land Intermodal (known as CSL Intermodal). Also placed under CSL Intermodal was CMX Trucking, Chessie's former trucking subsidiary.

NYK/Centex. Like other foreign-flag ocean carriers, NYK Lines established a North American subsidiary to manage double-stack train operations. NYK's subsidiary is called Centennial Express, or Centex. Centex is a wholly-owned subsidiary responsible for negotiating and overseeing intermodal contract operations on NYK's behalf, specifically NYK's double-stack commitments. What makes NYK and Centex of particular interest is NYK's recent purchase of GST Corporation (formerly Greater South Traffic), one of the largest and most complete U.S. shipper agents. To date, GST and Centex have been operated separately, in parallel.

"K" Line/Rail-Bridge. "K" line, Kerr Steamship Company, and International Transportation Services have a complex ownership pattern. Rail-Bridge is effectively a joint venture of partners who are otherwise related. Rail-Bridge serves as "K" Line's intermodal subsidiary, responsible for managing and marketing "K" Line's inland operations, specifically its double-stack trains. In this respect Rail-Bridge operates much like Centex. Rather than purchasing a shipper agent, however, "K" Line added a second subsidiary, Rail-Bridge Terminals Corporation (RBTC), to manage rail double-stack terminals in Elizabeth, New Jersey and in Lacolle, Quebec. Rail-Bridge and RBTC are parallel subsidiaries.

3. Multi-Modal Strategies

Ownership Versus Control. A major distinction can be made between companies that have chosen to own assets and entities in more than one mode, and companies that have chosen to control service in more than one mode through contractual or other non-ownership means. This distinction results in a spectrum rather than a bifurcation. In fact, every multimodal company uses a combination of ownership and control to move its traffic. Although CSX Corp. owns a railroad, a steamship line, and a trucking subsidiary, many of its double-stack trains use Trailer Train cars, and CSL's services to the West Coast are provided by other railroads under contractual interchange agreements. Although APC owns a steamship line, containers, some stack cars, a trucking company, a shipper's agent, and terminals, it does not own any of the railroads that operate its trains.

The customer generally does not care who actually owns equipment or facilities. The customer does demand that the system work smoothly, and that someone accepts responsibility when it breaks down. Either ownership or control can provide that capability if control is carefully arranged and managed. The vast majority of intermodal movements involve contractual and other other control arrangements to supplement the assets actually owned, and that practice is likely to continue for at least the near future.

One-Stop Shopping and Seamless Service. Two terms in current use, "one-stop shopping" and "seamless service," describe the goal of offering the customer a complete intermodal service through one organization. The object is to overcome one of the most serious obstacles to successful double-stack service, or to intermodal service of any kind: fragmentation.

Double-stack operations require successful performance and coordination of numerous functions. Few customers are willing to do all their own management and coordination, and one of the major roles of third party shippers is to relieve the ultimate customer of that burden. The goal of "one-stop shopping" is to allow the customer to use intermodal transportation with no more effort than is required to use a motor carrier. "One-stop shopping" necessitates a multimodal approach, whether implemented by ownership or control.

Regardless of the name given to the concept, "one-stop shopping" or "seamless" transportation" appears to be a prerequisite for successful domestic containerization, and for the long-run success of intermodal transportation in general.

Legal and Regulatory Issues. Many of the potential legal and regulatory issues in multimodalism were put to rest when CSX Corp. was permitted to acquire Sea-Land Services. Other prohibitions against the ownership or control of both railroads and motor carriers were effectively dismissed with the deregulation of the motor carrier industry. In both the Motor Carrier Act of 1980 and the Staggers Rail Act of 1980, Congress emphasized the importance of intermodal coordination. In 1984, the ICC removed most barriers to intermodal ownership, finding that the expansion of railroad-owned motor carrier operations was not likely to lead to rail domination of the mature motor carrier industry. The Commission now reviews such mergers on a case-by-case basis, and it is relatively easy for railroads to obtain motor carrier operating authority.

D. MARKETING AND THIRD-PARTY ISSUES

1. Marketing Issues

Customer Perceptions. Perception may be one of the biggest obstacles to domestic double-stack growth. From the perspective of many potential customers, rail intermodal services suffer from association with bad experiences those shippers have had with other rail services. TOFC service, in particular, suffers from customers' memories of the higher loss and damage, unreliable service, and poor organization that plagued piggyback operations a decade and more ago. Marketing efforts by American President Intermodal and other double-stack operators have encountered resistance from shippers who had bad experiences with intermodal service in years past and are reluctant to try it again.

The consulting firm of Temple, Barker & Sloane has undertaken periodic surveys of shipper attitudes towards intermodal transportion. The results of the most recent survey, taken in 1989, confirm the existence of serious perception problems. Figure 32 shows that shippers rate intermodal transportation well below trucks on eight key aspects of service. Less than half of the respondents rated intermodal excellent or nearly excellent in <u>any</u> service category. In contrast, at least 60 percent of the respondents rated trucks excellent or nearly excellent in <u>every</u> service category, and most categories were rated highly by more than 75 percent. Intermodal transportation was even rated lower than truck on price, indicating that truck rates are actually lower in some markets, or shippers are implicitly taking quality into account, or truck service reduces other costs, or all three.

The perceptions of non-users are particularly critical, since non-users account for most of the potential market. Figure 33 shows points of agreement and disagreement between users (40 percent) and non-users (60 percent). There is some good news for intermodal operators: users consistently rate intermodal service higher than non-users. But intermodal operators have not gotten their message across on some very basic points: non-users rate intermodal price, equipment availability, and service reliability much lower than do users. The better rating that users give intermodal on the ease of doing business may reflect their greater progress up a "learning curve" that constitutes a barrier to non-users. The top half of Figure 33 illustrates the "halo" problem, the areas in which intermodal service has improved, but still suffers from a bad reputation earned in the past. The existence of this negative "halo" has been

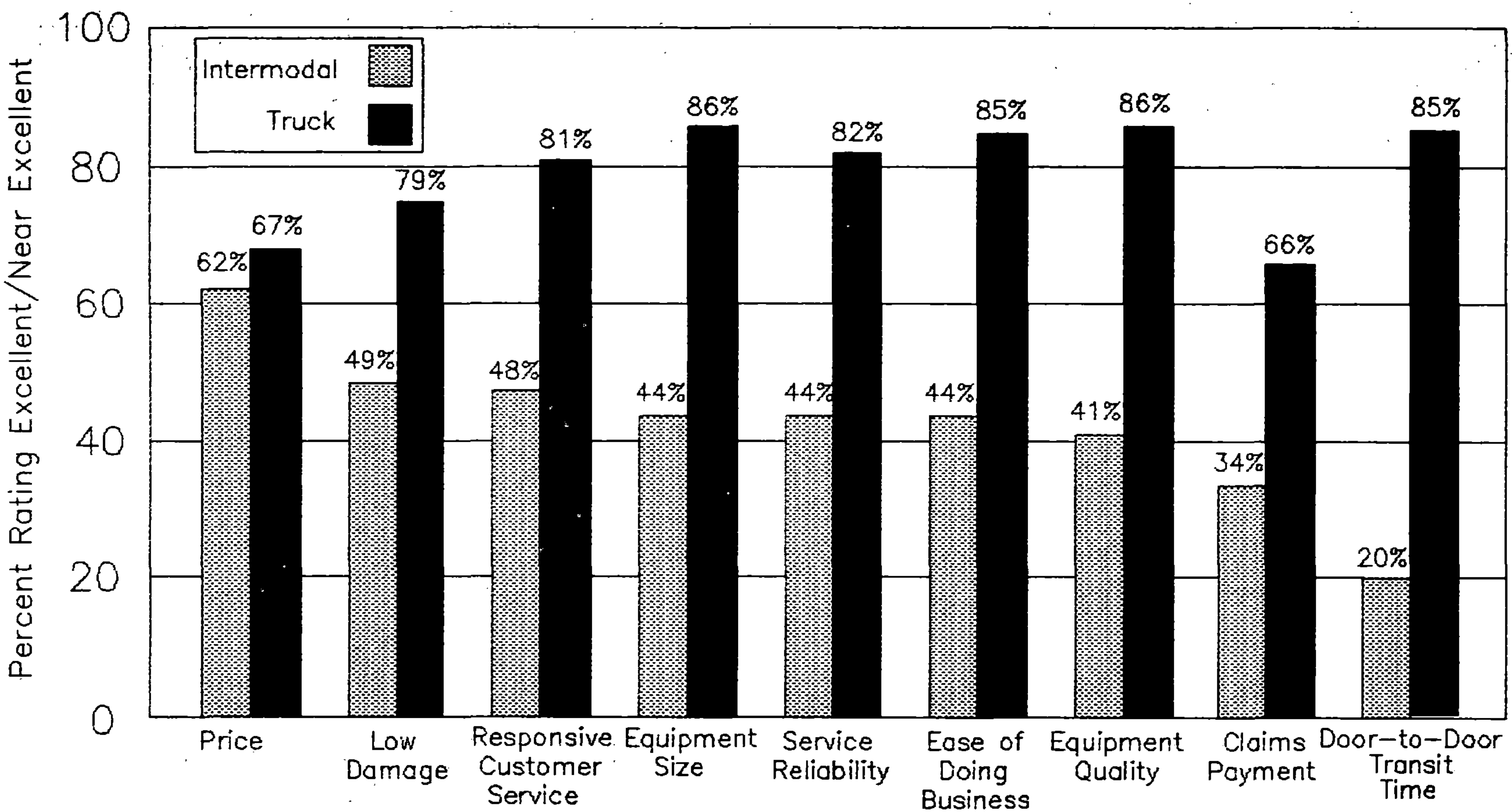


Figure 32: Shipper Perceptions of Intermodal vs. Truck

Source: Temple, Barker & Sloane
Traffic Management, June 1989

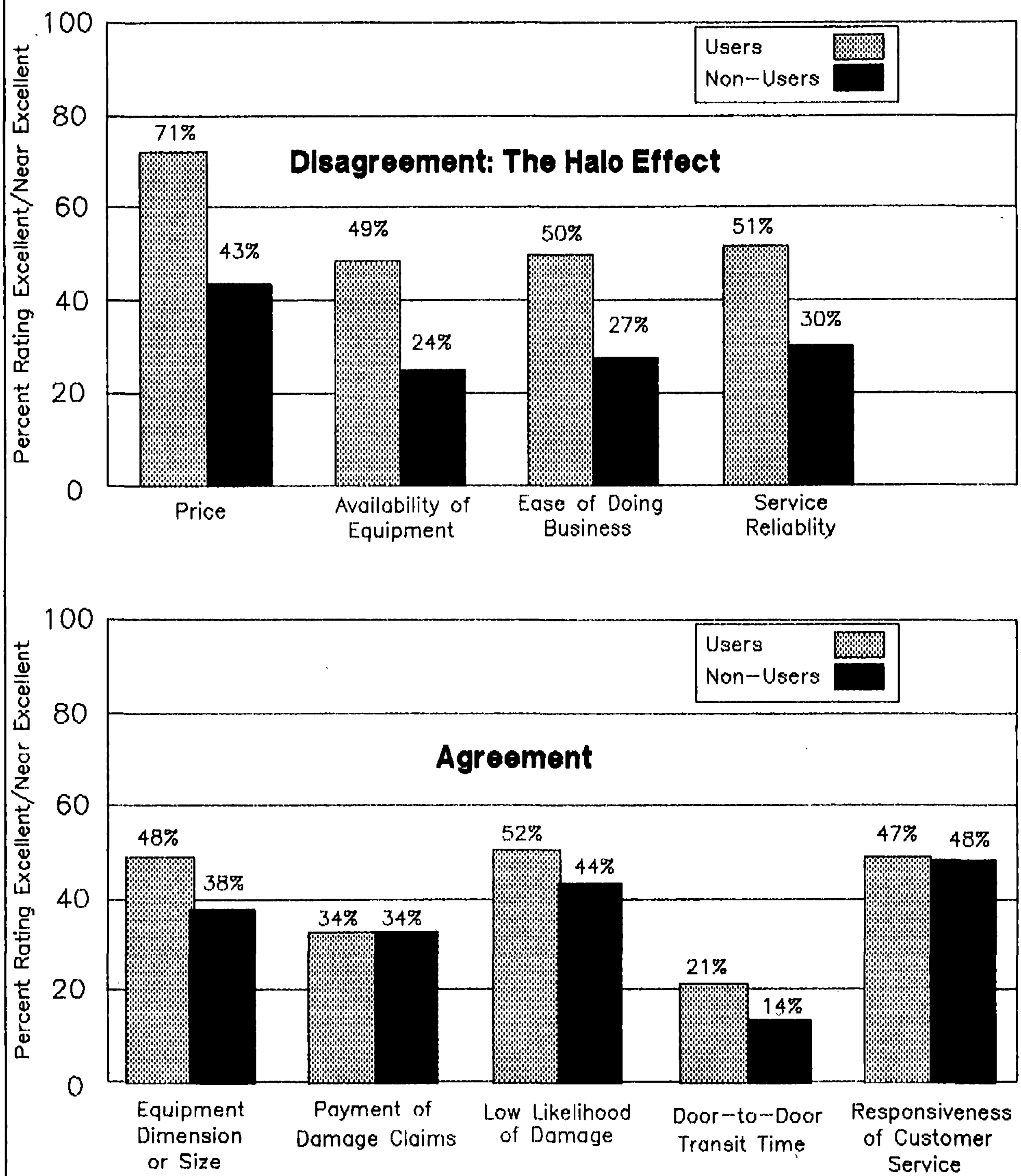


Figure 33

User and Non-User Perceptions of Intermodal

Source: Temple, Barker & Sloane
Traffic Management, June 1989

demonstrated repeatedly by market surveys and in focus group discussions sponsored by major intermodal operators.

The bottom half of Figure 33 contains some sobering findings: non-users rate intermodal poorly on five major aspects of service, <u>and users agree with them</u>. The responses on damages and claims are particularly striking. Intermodal operators have congratulated themselves publically on the reduction in loss and damage achieved by articulated cars, but a large portion of intermodal traffic still travels on conventional cars, and it is still damaged too often. Moreover, prompt handling of damage claims remains a serious failing of intermodal transportation, reflecting both the poor historical performance of railroads in handling claims and the fragmentation of intermodal responsibility.

Both users and non-users have low opinions of intermodal door-to-door transit time, and the survey found that poor door-to-door transit times were the reason most often given for not using intermodal service, or not using it more. As stated earlier, intermodal operators have seldom tracked door-to-door transit time in any organized way.

Double-stacks, as a line-haul technology, have improved on the image of piggyback in some key operational areas. Figure 34 shows that many shippers view double-stacks as superior to conventional piggyback in price, damage control, reliability, transit time, and equipment. Double-stacks have little or no perceived advantage, however, in customer service, ease of doing business, and claims payment, three areas where intermodal transportation in general is handicapped.

<u>Marketing Efforts</u>. Domestic containerization presents railroads with a major marketing challenge. For many years, the main target for railroad intermodal marketing has been the intermodal traffic of other railroads. Railroads market intermodal services to ocean carriers with some success. But ocean carriers constitute a small number of high-volume customers, with well-organized, concentrated traffic. The success of domestic double-stack service lies with an enormous number of potential domestic container shippers, whose traffic is unorganized and diffuse. Railroads can justify substantial marketing and sales expenses to pursue major

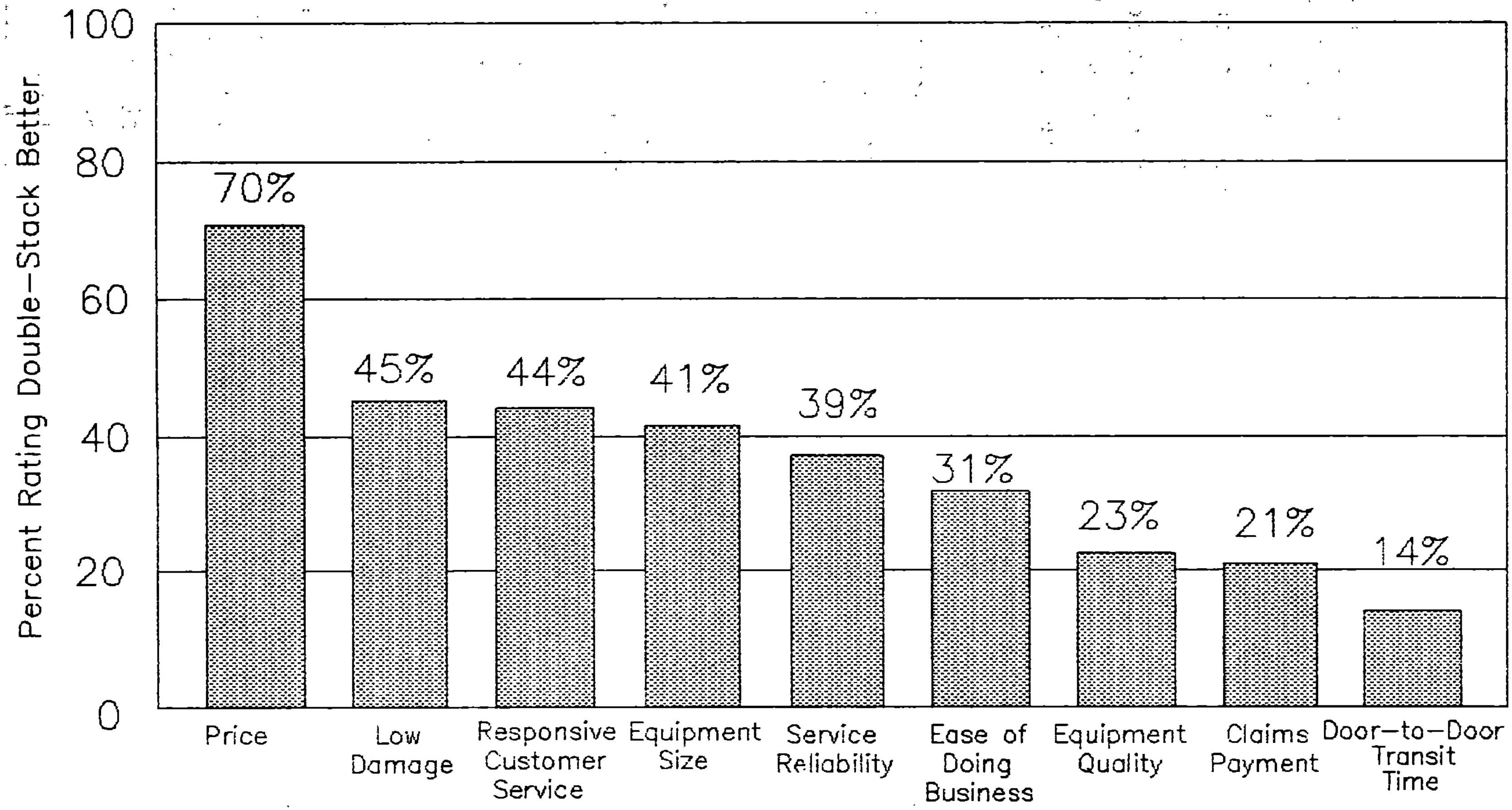


Figure 34: Shippers Preferring Double-Stack to Piggyback

Source: Temple, Barker & Sloane
Traffic Management, June 1989

ocean carrier accounts. Few domestic accounts, other than UPS and the largest third parties, could justify the same level of effort, especially when railroads are trying to minimize overhead. Who will undertake the required marketing effort for domestic double-stacks, and what will it cost?

As in railroad intermodal organizations, railroad roles in marketing have evolved differently on different railroads, and are likely to remain divergent for some time. Common practice in the recent past has been for railroads to market intermodal services to third parties, to ocean carriers, and to a few large national shipper accounts. Some railroads, such as Southern Pacific and Santa Fe, continue to market intermodal service on that basis. Union Pacific, which competes in many of the same markets, has effectively turned over much of the marketing and sales function to ocean carriers and multimodals with whom UP has "hook and haul" contracts.

Norfolk Southern's RoadRailer subsidiary, Triple Crown, engages in some retail marketing to shippers. Conrail's Mercury program will also incorporate some retail marketing, although details are not yet available. CSL markets to domestic and international customers of all kinds: shippers, third parties, and ocean carriers.

As in so many areas of the intermodal field, railroad marketing seems to be moving away from the middle ground. Railroads are either launching broader or more intensive marketing efforts (sometimes through subsidiaries), or simply marketing linehaul and terminal services under "hook and haul" contracts.

2. The Role of Third Parties

Over the last decade, railroads have increasingly relied on third parties such as shippers' agents, brokers, and shipper associations as their primary intermodal customers. The railroads have effectively been selling services wholesale. Only the very largest intermodal shippers, such as UPS or major retail chains, deal directly with the railroads to any appreciable extent. The railroads no longer have large intermodal sales forces, and their geographical coverage is limited. The railroads have allowed, and even encouraged, the third parties to become dominant.

Third parties freight forwarders, consolidators, shipper associations, shippers' agents, and licensed property brokers. The ocean carrier subsidiaries are a new generation of third parties. Each has a somewhat different role, but all serve as middlemen between the shipper and the railroad.

The licensed property brokers, commonly known as transportation brokers, have been one of the fastest growing segments on the intermodal scene. There were only a few licensed brokers before the Motor Carrier Act of 1980. By 1983 there were approximately 4,000, and today there are over 8,000. Licensed by the ICC, the brokers perform a variety of services that overlap those of the freight forwarder and the shippers' agent. A distinct difference is that a forwarder assumes liability and responsibility for the intermodal move, while a shippers' agent or broker lets the shippers and carriers work out liability among themselves. The rapid increase in the number of transportation brokers has increased the likelihood that some may be unqualified. Poor services from unqualified brokers would hurt the reputation of intermodal transportation in general, especially when the unqualified brokers blame other parties.

The various types of third parties have had a dramatic effect on domestic containerization in the U.S. Much of their success has been due to their ability to make the intermodal concept work more effectively than the rail carriers could. In 1988, Inbound Logistics magazine published a reader survey and concluded that "third party service providers heavily influence at least half of transportation buying decisions for almost one-fifth of the freight buyers." For domestic shipments, the survey found that "14.5% use third parties for 76% or more of domestic moves." Third party participation, however, is by no means universal: by 1990 "48.4% will still resist using third parties for even 10% of their shipments."

Third parties taking advantage of deregulation entered into agreements with the rail carriers and ocean carriers to use the ocean containers to move domestic cargoes back to port cities. This intermediation between rail and ocean carriers by third parties led to further expansion of the railroads' TOFC and COFC business. Third parties were later able to contract directly with the railroads for volume container moves of marine containers from ports of entry to inland destinations.

The third parties have taken on the full management obligations for door-to-door service. Starting with the pickup at the shipper's door, the third party provides the container (or a truck to handle the less-than-container shipments), and monitors the service. The shipment may be moved to a terminal for transloading from a truck or trailer into an ocean container, or moved directly to the rail yard. To this point, all the labor involved has been for the account of the shipper (loading the container or pickup vehicle) and the third party (terminal handling, drayage, etc.). On the other end of the rail movement, the third party retrieves the container at the rail terminal and delivers the loaded container either to the consignee, or to the third party's destination terminal where it is broken down and the individual consignments delivered to the consignees. Every segment other than the rail haul, but including obtaining the empty container to be loaded and the return of the empty container to the ocean carrier, has been managed by the third party.

Truckload and containerload transportation is a buyer's market. Third parties that want to grow faster than intermodal transportation itself has grown have been adding truck brokerage and cargo insurance to their activities to offer their customers a full range of competitive options. Management of third party companies has been strengthened to the point where major third parties are now effective marketing and operational organizations. Computerization, improved handling methods and better terminal facilities are now the norm rather than the exception.

<u>Competitive or Cooperative?</u> The issue of third party competition with carriers has been debated for as long as third parties have been working between shippers and carriers, and it will never be resolved to everyone's satisfaction. Third parties compete for domestic freight both among themselves and with railroads and ocean carriers who solicit

freight directly from shippers. The cooperation between third parties and the railroads seems complete in those markets where the railroad has not marketed its intermodal service with much success and the third party business is both large and profitable.

The third parties who structure their service to meet the demands of the shipper will be a major participant in domestic containerization. But the third parties will also have to have a strong marketing program to direct volume from the motor carrier industry to domestic containerization. Marketing of this type of service does not start and stop with the domestic shippers. Even before the service could be marketed to the shipper, the idea has to be accepted by the three entities necessary to make the service viable: the railroads, the truckers, and the steamship companies.

For many years, the railroads' relationship with third parties was simple: the railroads issued price sheets and expected third parties to sell the service. Railroads have begun to talk of partnerships. The growing sophistication of third parties and the increasingly formal relationship with the railroads has led to a few pioneering three-party service agreements between a railroad, an agent, and a shipper. One example is a recent 5-year agreement involving Hub City and Nabisco, including guaranteed rate and service levels, and management reports for the shipper.

Third parties will remain a strong influence in domestic containerization. Many shippers are not convinced that dealing with a single railroad or ocean carrier produces the best price/service packages available. On the other hand, there are still a lot of shippers that prefer to deal directly with the railroad for service, price, performance, etc. Each railroad will create a marketing strategy for dealing with both shippers and third parties; few will go all one way or the other.

E. INSTITUTIONAL ISSUES

1. Intermodal Functions

The functions that must be performed in intermodal transportation have not changed with the introduction of double-stacks. In the long run, the potential customer will judge the attractiveness of intermodal transportation -- double-stack or other -- according to how well those functions are performed, regardless of who performs them.

The intermodal market will not tolerate mediocrity. Each participant must determine which functions it can perform efficiently, competitively, and profitably. Functions that cannot be performed efficiently will be neither competitive nor profitable, and the provider is unlikely to endure in that function. The better alternative is cooperation with efficient providers of that function, even if with sometime competitors.

It is not necessary, and it may not always be desirable, for one firm to perform every function. The crucial point is that each firm must be a part of a chain of firms, or a succession of partnerships, that performs all the functions efficiently, competitively, and profitably. Such arrangements have been termed "strategic partnerships" to denote the need for a long-term, structured relationship in pursuit of a common goal. The relationship between API and UP, in which API is assuming much of the responsibility for marketing the intermodal line-hauls performed by UP, is one example of a strategic partnership.

Some participants, especially the railroads and ocean carriers, may have to form multiple strategic partnerships to serve different markets. For example, Santa Fe has a long-standing working relationship with Conrail for piggyback service between Los Angeles and New York. But Conrail also handles API's double-stack business in the same corridor in conjunction with UP and CNW, and Santa Fe recently entered a voluntary coordination agreement with BN for service between Los Angeles and Memphis.

Some participants may not choose to form partnerships because their role is best performed as a neutral provider of services to all. Equipment manufacturers and leasing companies, for example, are not likely to restrict their potential market by working more closely with some customers than with others. Terminal operating contractors may successfully serve carriers that compete with one another; some contractors already do so.

The success of these strategic partnerships will rest largely on the effectiveness of coordination and communication. The need for coordination in intermodal operations is obvious, as coordination is imperative for efficiency and reliability. The need for coordination in marketing, contract terms, and customer service is less obvious, but just as crucial if the resulting product is to appear "seamless" to the customers. Disputes among the partners on claims resolution, customer billing, rate making, or shipment tracing will quickly and permanently alienate customers who can obtain superior service from other intermodal operators -- or from truckers.

2. Institutional Issues: Emergence of an Intermodal Industry

Rail Intermodal Organization. There is a definite trend within the railroad industry to recognize intermodal traffic as a separate line of business, and to reorganize accordingly. No two railroad organizations are alike, but most share some common features:

- specific responsibility for intermodal at a high level, usually vice president;

- a tendency to combine several intermodal functions -- sales, marketing, operations, terminals -- in a single department;

- treatment of intermodal transportation as a separate profit center, with at least some separate accounts; and

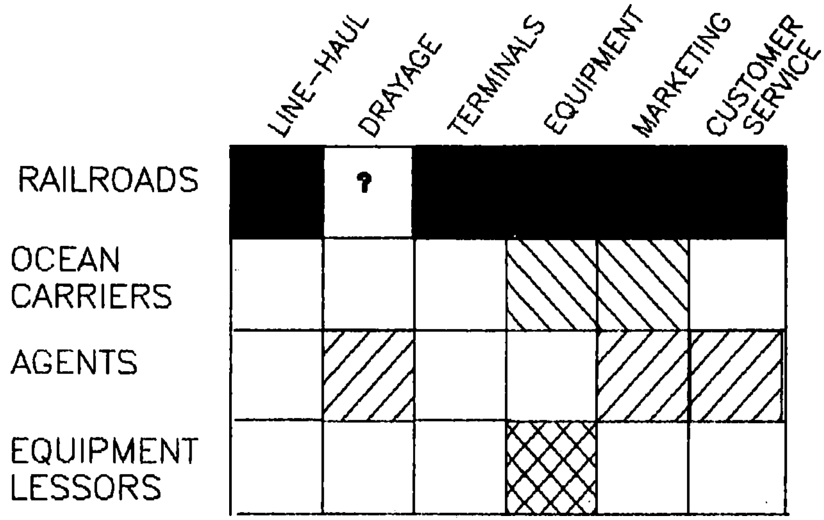
- the emergence of intermodal as a separate business group or entity.

A prime example is CNW's Global One Transportation, which has responsibility for intermodal operations, marketing, sales, equipment, and terminals. Global One is treated as a separate business group, with its own profit and loss statement. The most publicized example is CSX/Sea-Land Intermodal (CSL Intermodal, or CSL) which is responsible for the combined inland intermodal businesses of the CSX railroads and Sea-Land Services.

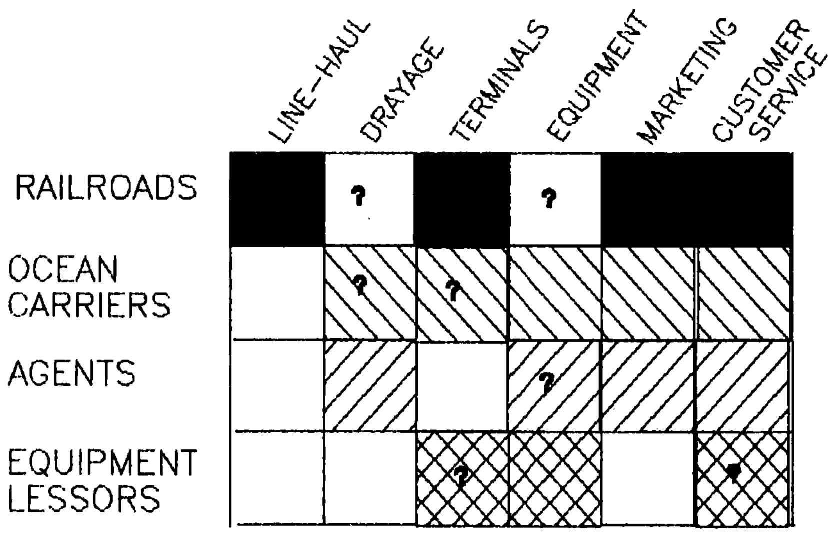
Union Pacific has taken an entirely different approach. UP's major double-stack customers, API, Maersk, and "K" Line, have "hook and haul" contracts that do not involve UP in ongoing marketing or buyback roles. Burlington Northern has taken still another approach with the creation of BN America (BNA), a domestic container business group. Norfolk Southern has a dual intermodal organization: Piggyback and double-stack services are offered through NS's marketing and operating departments; RoadRailer service is offered by NS's Triple Crown subsidiary.

Industry Organization. From one perspective, organization of the intermodal marketplace has become confusing and complex. There is no longer a single, well-defined railroad role. Ocean carrier roles are just as diverse, and range far inland from the ship. Ports have undergone a radical change in their scope of action, and find themselves involved in everything from computers to railroad tunnels. The firms involved range from small shipper agents and local draymen to major ocean carriers, railroads, third parties, and multimodals. Even within categories, there are vast differences: no two major railroads are organized quite alike, and the same can be said of ocean carriers and their subsidiaries.

Figure 35 illustrates the changing roles. As recently as 1980, the roles were relatively stable and well-defined. There were only small differences among the range of services offered by the various railroads, and the "menus" of competing ocean carriers and third parties were likewise similar to one another. In 1989, all the roles are changing, not only between modes but within modes. No two major railroads offer the same menu of services, and the only completely stable function has been the railroads' performance of the actual rail line-haul. Ocean carriers and their subsidiaries vary even more than the railroads.



1980 - Static Roles



1989 - Changing Roles

Figure 35
Changing Intermodal Roles

Despite the progress made thus far, both international and domestic double-stack services remain limited by fragmentation. The TBS survey found that 40 percent of intermodal users, and 43 percent of non-users, cited fragmentation as a major reason for not using intermodal transportation more, or not using it at all. Double-stack transportation has developed, and continues to develop, despite its fragmentation. But double-stack transportation cannot attain its ultimate potential unless the necessary functions are successfully integrated in the eyes of the customer.

From a purely intermodal perspective, however, these developments make sense, and they are part of a single trend: the emergence of an intermodal industry. Intermodal transportation, with double-stack service as its most prominent manifestation, is becoming an industry within an industry. In railroads, ocean carriers, and ports, intermodal transportation is being recognized as a separate, specialized line of business. Double-stack container transportation is the most vivid illustration, since it involves different equipment, functions, and participants than piggyback or carless technologies.

Figure 36 illustrates this point. Each of the participating groups, by one strategy or another, is distinguishing a subset of its activities involved in intermodal transportation. These subsets may just be departments or individual employees, or they may be organized as business groups or subsidiaries. Intermodal business groups may have more in common and more need to communicate with other intermodal business groups than with their parent organizations. Relationships between intermodal business groups and parent organizations are likely to involve capital allocation, financing, budgeting, and planning. Relationships among different intermodal business groups are more likely to involve day-to-day operations, changing market conditions, short-term leases, or contract negotiations. Increasingly, double-stack customers will be dealing with the "intermodal industry," not with the parent organization.

In the long run, domestic double-stack service might best be regarded as an offering of the intermodal industry rather than a function of either railroads or ocean carrier subsidiaries. No one firm by itself can develop and operate a nationwide, door-to-door, double-stack network.

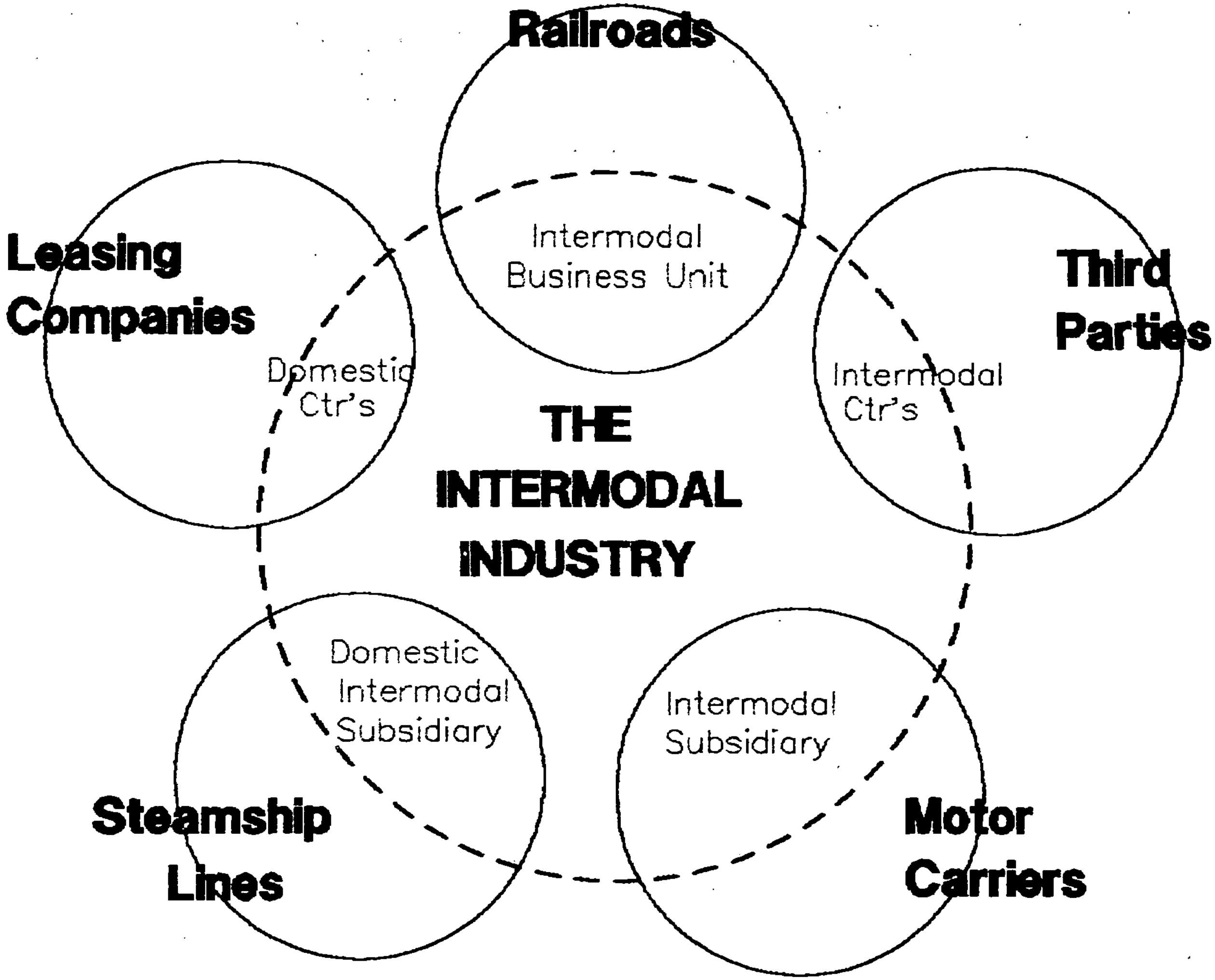


Figure 36

The Emerging Intermodal Industry

The intermodal industry as a whole, however, has the means to do so, and to realize the potential of domestic containerization.

3. Strategic Alliances

Strategic alliances are forming within the emerging intermodal industry. One of the major motivations for forming strategic alliances between players is to achieve the same "seamless" "one stop shopping" or "total transportation" that multimodals are trying to achieve. Indeed, the multimodals themselves have their limits, and some have formed strategic alliances to overcome those limits. For example, the relationship between API and UP can be termed a strategic alliance. As multimodal as APC may be, it does not operate trains, and UP does. UP, in return, relies on API for much of its domestic intermodal marketing effort.

Strategic alliances will likely function as less formal, less capital-intensive, and less risky alternatives to multimodal organizations for many intermodal firms. Moreover, strategic alliances can overcome some of the institutional barriers to intermodal expansion: Burlington Northern need not purchase Santa Fe to obtain access to Southern California, and UP need not purchase a third party to enlist the help of a retail marketer. Srategic alliances may therefore also extend the multimodal organization in ways that would otherwise be legally or financially difficult.

4. Value-Added Double-Stack Strategies and Product Differentiation

Every historical and current development points toward increased competitive pressures on intermodal transportation in general, and on double-stacks in specific. The pressure has made it increasingly difficult for carriers or third parties to prosper by merely providing generic double-stack transportation or double-stack equipment. In such an environment, unadorned linehaul double-stack transportation becomes a commodity, and it can achieve only the low unit revenues and profits typical of price-sensitive commodities. The same observation applies to the supply of double-stack cars, containers, and chassis, all of which have become undifferentiated commodities.

The physical elements of double-stack operations are relatively straightforward, and the intermodal industry has expertise in all categories: cars, containers, trailers, chassis, tractors, ramps, and lift equipment. The nexus of the problem is how to organize the operation to provide a flexible, differentiated, and profitable intermodal product. There may be more than one way to conceive a differentiated product, more than one approach to a profitable package, and more than one end result. It is not necessary to determine a single, optimal mix of services: the optimal mix will vary with different circumstances. It _is_ necessary to focus on long-term profitability, and to adjust the mix of services to match.

The implication is a need for what has been called "value-added" transportation. Value-added transportation incorporates any or all of the functions required to complete the door-to-door intermodal package, including some functions that were traditionally performed by shippers. Customers are willing to pay higher rates to carriers who accept risks, or closely manage the movement on the customer's behalf. Customers are not willing to pay higher rates if they must perform such functions themselves.

Railroads have recently launched several attempts at creating "brand-name" intermodal services:

- o ATSF's Quality Service Network and Quality Stack Service;
- o BN's Expediters;
- o CSL's Frequent Flyer and Select Service;
- o NS's Triple Crown;
- o SP's Trackstar and DRGW's Railblazer; and
- o UP's BulkTainer.

The actual services behind these names vary widely. Some are high-service, short-haul piggyback trains (Quality Service Network, Expeditors, Track-stars, and Railblazers). Others are double-stack services that have been singled out for special promotional attention (Quality Stack Service, Frequently Flyer). Three are door-to-door services (Select Service, Triple Crown, and BulkTainer), but only one includes door-to-door domestic double-stack service (Select Service, combining CSL Intermodal and CMX for drayage).

Railroads have begun to offer the beginnings of value-added services. Conrail's Mercury System incorporates computer-aided dispatching. Conrail also has begun to provide truck-competitive cargo insurance. SP has introduced Container Bridge, a chassis pool and drayage system, in support of its Los Angeles ICTF. BN provides its customers with ShipSmart, a logistics software package. UP has two value-added subsidiaries: UP Logistics and UP Technologies.

Unfortunately, railroads start from a "no frills" or "value-subtracted" position relative to motor carriers, and many of the innovations now being tried simply move railroads closer to the motor carrier standard. Yet such efforts may perform the vital function of germinating genuine service competition among the railroads and their partners.

F. PROSPECTS FOR INDUSTRY-WIDE CONVERSION

1. Market Forces and Incentives

Two closely related questions have to be addressed in any consideration of industry-wide conversion of rail intermodal traffic to containers:

- o Is it probable that existing market forces will bring about a large-scale network of domestic double-stack operations?

- o If not, is some coordinating or policy-making effort required to create a domestic double-stack system?

The progress of domestic containerization thus far and the history of maritime containerization, suggest that market forces will indeed achieve a substantial degree of domestic containerization.

All the findings of this study indicate that market forces presently at work will lead to the development of an effective double-stack network for international and domestic containers. This network may not be optimal in the near future: there are a number of operational and marketing shortcomings and some institutional obstacles identified in this study that may hinder the intermodal industry in realizing the full potential of double-stack intermodal service. Moreover, until railroads, third parties and intermodal operators begin to offer a differentiated product -- brand-name transportation or value-added services -- they will continue to compete on price and remain highly vulnerable to improvements in truckload economics. Profitability and traffic incentives exist for the railroads and other participants to form partnerships or strategic alliances in pursuit of higher service quality, improved customer service, and a premium transportation product. The formation of partnerships and alliances will be facilitied by the emergence of the "intermodal industry".

There still exist some areas where the creation of industry standards would hasten progress. Although container sizes are not a major issue, the industry would benefit from early resolution of the ISO "wide body" container controversy. The industry would certainly benefit from agreements on standards for Automatic Equipment Identification, Advanced Train Control Systems, and Electronic Data Interchange.

Some physical impediments still exist. The railroads have made substantial progress on removing clearance restrictions, with significant help from state and local government agencies in some areas. The industry itself appears able to maintain adequate terminal capacity and equipment fleets. Urban terminal and port access, rather than rail access, may be a growing problem that cannot be solved from within the intermodal industry.

The critical issue, if it can be narrowed to one, is institutional: railroad and intermodal industry commitment to intermodal business, specifically double-stacks. The highly competitive market for intermodal transportation will not tolerate mediocrity, and, overall, railroad operations, marketing, and customer service have been mediocre. Double-stack service started and grew because some ocean carriers were willing to make a commitment and assume some risks. In order for the railroads to realize the full potential of domestic and international double-stack service, they will have to do the same.

2. The Trailer-to-Container Conversion

There has been considerable speculation regarding the extent to which piggyback trailer traffic will be converted to domestic containers, and the time required for such a conversion. There are several key factors in the trailer conversion issue:

- the extent to which some of the largest intermodal customers are willing to convert to containers;
- the relative ability of double-stacks and piggyback to compete in short-haul and niche markets;
- the prospects for replacement or retirement of the existing piggyback trailer fleet;
- the ability of refrigerated domestic containers to compete with refrigerated trailers for perishable commodities; and
- the lifetime of the current piggyback railcar fleet.

Current data suggest that the conversion of trailers to containers is proceeding slowly. Over the first 36 weeks of 1989, trailer ton-miles were down by 1.2 percent compared to 1988, and container ton-miles were up by 9.6 percent. Trailers, however, accounted for 60 percent of the total, and at the present rate of change trailers would still account for 48 percent after five years.

Less-than-truckload (LTL) motor carriers are emerging as a significant source of domestic intermodal traffic, and their operations rely on trailers. They will be hesitant to convert to containers unless the containers served a distinct market niche. The 28-foot trailers LTL carriers use do not readily convert to any existing container size, but they can be accommodated on conventional TOFC flatcars (notably in SP's Triple Trax service).

Some major intermodal customers, notably, United Parcel Service (UPS) and the U.S. Postal Service, used trailers almost exclusively until very recently. APC's Chicago-Dallas domestic container route has attracted some UPS and Postal Service traffic, but that traffic is still a tiny part of the amount that still moves by trailer.

The existing piggyback trailer fleet is many times larger than the existing domestic container fleet. Replacements have not kept pace with retirements in recent years, however, so the trailer fleet has been aging and shrinking. The result is that a substantial portion of the trailer fleet is at or near the end of its expected life. Absent more extensive replacement or refurbishment programs, the piggyback fleet will begin to decline rapidly within the next few years, speeding the conversion to containers. Some observers have expressed concern that the lack of replacements will keep older trailers active too long, exacerbating the TOFC image problem. Some major leasing companies have announced substantial purchasing or refurbishing programs for 1989, but the TOFC trailer fleet will probably continue to shrink overall.

Refrigerated piggyback trailers have a small, but well-established market share in perishable commodities. Their use has not totally stemmed the tide of diversion from rail to truck, but refrigerated piggyback trailers have captured much of the fresh produce previously handled in refrigerated boxcars. Until refrigerated container service is well established and accepted by shippers of perishables, this traffic segment will stay in trailers.

Some in the intermodal field believe that massive trailer retirements and the superior performance of double-stacks will virtually eliminate trailers within 5-10 years. The mitigating factors discussed above, however, suggest that trailers will still be an important part of the intermodal business through most of the 1990's. If trailers are not replaced and refrigerated domestic containers are successful, the conversion will be hastened and might be largely complete within the 10-year time frame.

In summary, it appears that TOFC services will still be offered for some time. They are most likely to persist where major trailer shippers (such as UPS) require premium service, and in those shorter, less-dense corridors where RoadRailer services do not emerge.

3. The Potential For Diversions From Boxcars

Commodities that can be carried in boxcars can generally be carried in containers. Containers are physically capable of carrying most of the remaining boxcar traffic, but whether they can do so economically is an open question.

Boxcars are used primarily in inter-plant or factory-to-warehouse movements of goods for further processing or subsequent distribution. Many of the boxcars in use are far more than plain metal boxes on wheels. Food products, such as canned goods or beer, require insulated cars with load-restraining devices. Auto parts require specialized racks and bracing, or oversize cars up to 90 feet long. Moreover, some of these cars have become effectively integrated into the production process, as in the case of paper plants with conveyors that extend into the boxcar. As with any piece of specialized equipment, specially equipped or sized boxcars are difficult to fill with backhaul freight.

Boxcars have poor utilization relative to intermodal equipment, in terms of both the portion of time spent loaded and the cycle time between loads. The general lack of backhauls and the need for repositioning means that boxcars typically travel only a little more than half their miles with revenue loads. A report completed in 1988 for the ICC Office of Transportation Analysis found that boxcars made, on average, 11-12 trips per year in 1979. By 1982, with a recession and a boxcar surplus, the average had declined to about 8 trips per year. Utilization rose gradually thereafter, and now stands at about 11 trips per year.

Boxcars can survive financially under such conditions because, at present, they are plentiful and cheap. Most observers consider that the net revenue potential of much existing boxcar traffic is too slim to justify fleet replacement. Much of the boxcar fleet is relatively new, however, and is likely to be serviceable through the 1990's.

It may be difficult for double-stacked domestic containers to compete in boxcar niches, so long as both the boxcars and the niches still exist. Double-stacks have to achieve high utilization and frequent backhauls to keep the cost down, and may not survive in the economic environment of the boxcar. Many major boxcar shippers and receivers, such as lumber mills, paper mills, or packing plants, are located away from major intermodal hubs, and containers would incur large drayage costs to serve them. According to a Southern Pacific spokesman, a significant number of such customers do not even have good connections to major highways.

Boxcar niches endure because of cost advantages over other modes. For the Boxcar Exemption report, Reebie Associates surveyed boxcar shippers and found that one-half expected their boxcar use to remain the same over the next five years, one-third expected their boxcar use to decline, and one-sixth expected their boxcar use to increase. A study completed by Railbox in December, 1988, concluded, "...over 50 percent of existing boxcar traffic cannot be converted to double-stack containers without increased transportation costs." An assumption that boxcar shippers would be willing to pay extra for current double-stack services does not seem warranted.

Another near-term obstacle may be the profitability of boxcar traffic to the railroads. Boxcar traffic, although smaller in aggregate, is markedly more profitable to the railroads than intermodal traffic. Even if, as The ICC's Boxcar Exemption Report notes, the comparison in Figure 47 is somewhat overstated, the disparity in profitability conforms to conventional wisdom in the railroad industry. There is thus an incentive for railroads to keep the traffic in boxcars as long as possible, and to encourage conversion to domestic containers only as a means of avoiding reinvestment in boxcars or loss of the traffic to trucks.

Despite these obstacles, double-stack containers will eventually penetrate some boxcar niches. In one area, auto parts, they have already done so.

Detroit-Chicago-Texas-Mexico double-stack services established by API, UP, and SP are based largely on movements of domestic auto parts.

In order to convert the majority of boxcar traffic, domestic container services will have to offer boxcar shippers some advantage that surpasses the cost difference. Shippers have almost invariably been willing to pay more for more timely, reliable, and convenient services that mesh with their distribution systems. Changing production and distribution practices in other industry segments may open other boxcar niches and yield additional opportunities for domestic double-stack service.

4. Potential Further Truck Diversions

Further substantial truck diversions to double-stacks will require service improvements, innovations, and expansions to reach new customers. In order to attract and serve the remaining relevant truckload traffic, double-stack services will have to:

- provide competitive refrigerated service;
- extend the competitive drayage range;
- strengthen services and service reputation in lightly served corridors; and
- extend truck-competitive service to secondary corridors.

Data on the entire relevant truck market suggest that the potential is great. The challenge presented to railroads and other double-stack participants is substantial. There are two major caveats to this discussion of possible truck diversions.

The first caveat is a reiteration of the assumptions made in developing the rail cost criteria. These criteria assumed 100 percent utilization of double-stack cars and containers, perfectly balanced traffic, and minimum attainable operating costs (including three-person crews). These assumptions are clearly optimistic, and exceed the current abilities of the rail double-stack system. As pointed out earlier, the balance and utilization issues are critical and interdependent.

Taking the truck flows between Seattle and Los Angeles as an example, the balance problem is clear:

Seattle - Los Angeles Traffic Flows

	Rail Units	Truck Units	Total
Northbound	4,141	112,008	116,149
Southbound	6,223	56,940	63,163
Total	10,364	168,948	179,312

How can a double-stack service attract over 112,008 northbound truckloads while carrying only about half that number southbound, when very high equipment utilization is required to compete with trucks? The answer is that it cannot. The reason that the truck totals appear to be imbalanced is that the truck movements are frequently triangulated: northbound from Los Angeles to Seattle; repositioned to points such as Bellingham, Wenatchee, Walla Walla, Pasco or Okanogan; and reloaded to Los Angeles. Double-stack service cannot be triangulated in the same manner: the drayage and repositioning costs would be prohibitive. Thus, although the truck traffic shown in earlier tables is, in theory, accessible to double-stack services, in practice double-stacks may not be able to divert all of it.

The second major caveat is a reiteration of the earlier discussion of truck rates. As pointed out, the truck rates considered in this study have been declining since 1980, and may be at historic lows in real terms. Likely increases in truck rates due to factors such as increased safety requirements, higher fuel taxes, or driver shortages and higher labor costs that do not similarly affect rail rates, would make significantly more truckload traffic accessible to double-stacks.

VIII. OVERALL CONCLUSIONS

The results of the study confirm the enormous growth potential of double-stack container systems, particularly in domestic freight. The results suggest that double-stack services can be fully competitive with trucks in dense traffic corridors of 725 miles or longer. In such corridors, there is sufficient rail and truckload traffic to multiply the existing domestic double-stack traffic several times over. Beyond these major corridors, the results suggest the existence of further opportunities in secondary corridors, in outlying areas near major hubs, and in refrigerated commodities.

This study identifies several obstacles to achieving that potential. None is insurmountable, but all will require substained commitment of resources and management attention to one objective: provision of improved, reliable, door-to-door service. Some obstacles are technical, involving the features of double-stack cars and containers, the efficiency and reliability of operations, and the accommodation of new traffic patterns. The more serious obstacles, and those requiring the most immediate attention, tend to involve marketing, management, and organization.

Full realization of the double-stack potential may require the railroad industry to take unaccustomed steps into marketing, sales, and customer service. The alternative is to become strictly line-haul contract carriers, and rely on third parties or ocean carrier affiliates for marketing, customer service, door-to-door management, and perhaps even terminal operations.

For ports and ocean carriers, the implications are mixed. Ports will be under continuous competitive pressure to accommodate international double-stack growth, but will be only indirectly affected by domestic containerization. Ocean carriers, too, will be subject to competitive pressure, but may find new opportunities in meshing their international container movements with a growing domestic double-stack service.

The advent of double-stack container systems has dramatically altered intermodal transportation. New firms have entered the field, most prominently the ocean carriers and their affiliates. Existing firms have new roles, and have come together in new alliances. A distinct intermodal industry is emerging. Underlying all of this activity is a belief in the potential growth of domestic and international double-stack services and traffic. The technical characteristics of double-stack container systems yield lower line-haul costs and an improved ride relative to conventional piggyback. The intermodal industry is striving to turn these advantages into competitive rates, improved profitability, drastically improved service, and a larger share of the nation's freight.

The study concludes that existing market forces will bring about the development of an efficient double-stack network to serve both domestic and international traffic. There are some areas, notably in line clearances and highway/rail access, where public sector involvement may be helpful. The degree to which double-stack container services attain their potential, however, depends on the ability of intermodal industry to meet the technical marketing, managerial, and organizational challenges it faces.

APPENDIX TABLES

Appendix Table 1

UMLER/AAR CARTYPE RESTRICTIONS
FOR BOXCAR TRAFFIC

CARTYPE A _ _ _ , EQUIPPED BOXCARS

1st Numeric:	Include 1-4 (under 59')
	Exclude 5-8 (over 59')
2nd Numeric:	Exclude 0-1 (specialized)
	Include 2-4 (general)
	Exclude 5 (specialized)
3rd Numeric:	Include All (door sizes)

CARTYPE B _ _ _ , UNEQUIPPED BOXCARS

1st Numeric:	Include 1-4 (under 59')
	Exclude 5-8 (over 59')
2nd Numeric:	Include All
3rd Numeric:	Include All

CARTYPE R _ _ _ , REFRIGERATED CARS

1st Numeric:	Include 1-4 (under 59')
	Exclude 5-8 (over 59')
2nd Numeric:	Include All
3rd Numeric:	Include All

Appendix Table 2

STCC COMMODITY CODE RESTRICTIONS
FOR BOXCAR TRAFFIC

01 - Farm Products:
Include: 0112 - Cotton
01191 - Fodder or Hay
01194 - Sweet Potatoes
01195 - Other Potatoes
012 - Fresh Fruits
013 - Fresh Vegetables
Exclude: All others, since bulk grains or feeds would be poor candidates.

08 - Forest Products:
Exclude: Since primary barks, logs and gums would be poor candidates.

09 - Fresh Fish: Exclude

10 - Metallic Ores: Exclude

11 - Coal: Exclude

13 - Crude Petroleum, Natural Gas: Exclude

14 - Non-metallic Minerals: Exclude

19 - Ordinance or Accessories: Exclude

20 - Food or Kindred Products:
Include: 2012 - Meat, frozen
2013 - Meat Products
(Exception: 20139 - Meat Products, NEC; a dirty commodity)
2023 - Condensed or Evaporated Milk
2025 - Cheese or Special Dairy Products
203 - Canned Foods
20431 - Cooked Cereals
2047 - Pet Food
205 - Bakery Products
206 - Sugar
207 - Confectionary or Related Products
208 - Beverages
209 - Misc. Food Preparations
Exclude: All Others, mostly bulk or highly perishable products.

21 - Tobacco Products: Include

22 - Textile Mill Products: Include

Appendix Table 2

STCC COMMODITY CODE RESTRICTIONS
FOR BOXCAR TRAFFIC
(Continued)

24 - Lumber or Wood Products:
Include: 24214 - Hardwood Stock or Parts
24215 - Hardwood Flooring
24219 - Lumber or Dimension Stock, NEC
2429 - Misc. Mill Products
243 - Millwork, Plywood, Veneer
Exclude: All Others. Most dimension lumber, as opposed to high-value specialties, is more likely to stay in boxcars or shift to center-beam cars.

25 - Furniture or Fixtures: Include

26 - Paper, Pulp, or Allied Products:
Include: 262 - Paper
(Exception: 26211 - Newsprint, which requires special handling)
263 - Fibreboard, Paperboard
264 - Paper Products
265 - Containers or Boxes
266 - Building Paper or Building Board
Exclude: All Others, such as pulp.

27 - Printed Matter: Include

28 - Industrial Chemicals:
Include, under the assumption that chemicals packaged to ship in boxcars can also travel in containers.

29 - Petroleum or Coal Products:
Include, under the same assumption.

30 - Rubber or Misc. Plastic Products: Include

31 - Leather or Leather Products: Include

32 - Clay, Concrete, Glass, or Stone Products:
Include: 322 - Glass or Glassware
326 - Misc. Pottery
329 - Abrasives, Asbestos, or Misc. Non-metallic Mineral Products
Exclude: All Others, such as flat glass, brick, or cement blocks.

33 - Primary Metal Products:
Exclude, since these are heavy-loading commodities and poor candidates for regular containerization.

34 - Fabricated Metal Products: Include

Appendix Table 2

STCC COMMODITY CODE RESTRICTIONS
FOR BOXCAR TRAFFIC
(Continued)

35 - Machinery:
Include, assuming that most such products that are shipped in boxcars, rather than on flat cars, can be containerized.

36 - Electrical Machinery, Equipment, or Supplies:
Include, on the same assumption, and knowing that Maytag regularly ships appliances in containers.

37 - Transportation Equipment:
Include:
37112 - Set-up (assembled) Autos
37115 - Knocked-down (disassembled or unassembled Autos
3712 - Auto Bodies
3714 Auto Parts and Accessories
375 - Motorcycles, Bicycles, and parts
379 - Misc. Transportation Equipment
38 - Instruments, Photographic Goods, etc.
Exclude: All Others.

39 - Misc. Products of Manufacture: Include

40 - Waste or Scrap:
Include, under the same packaging and fit assumptions made in other categories. Containers regularly carry waste and scrap as exports.

41 - Misc. Freight Shipments: Include

42 - Containers, Carriers, or Devices, Shipping, Returned Empty:
Include, since we have by equipment choice eliminated marine containers on flatcars.

43 - Mail or Express: Include

44 - Freight Forwarder: Include

45 - Shipper Association: Include

46 - Misc. Mixed Shipments: Include

47 - Small Packaged Freight: Include

APPENDIX TABLE 3

— North Atlantic
11 Boston
12 New York
13 Philadelphia
14 Other Delaware River Ports
15 Baltimore
16 Other Chesapeake Bay Ports
17 Norfolk
18 Other Hampton Roads Ports
19 Other North Atlantic Ports

— South Atlantic
21 Wilmington, NC
22 Charleston
23 Savannah
24 Jacksonville
25 Miami
26 Other South Florida Ports
27 Puerto Rico/Virgin Islands
28 Other South Atlantic Ports

— Gulf
31 Tampa/St. Petersburg
32 Mobile
33 Other Central Gulf Ports
34 New Orleans
35 Mississippi River System Ports
36 Lake Charles/Beaumont/Port Arthur
37 Houston/Galveston
38 Corpus Christi
39 Other West Gulf Ports

— Great Lakes
41 Lake Michigan Ports
42 Lake Erie Ports
43 Other Great Lakes Ports

— Pacific Southwest
51 Long Beach/Los Angeles
52 Other Southern California Ports
53 Oakland/San Francisco
54 Other San Francisco Bay/Sacramento
55 Other Northern California Ports
56 Honolulu/Hawaii Ports

— Pacific Northwest
61 Portland, OR
62 Other Columbia River Ports
63 Seattle/Tacoma
64 Other Puget Sound Ports
65 Other Pacific Northwest Ports
66 Alaska Ports

```
---- 11 Boston
0401 11 Boston, Mass.
0417 11 Logan Airport, Mass.

---- 12 New York
1000 12 New York, NY CD
1001 12 New York, NY
1003 12 Newark, NJ
1004 12 Perth Amboy, NJ
1012 12 John F. Kennedy Airport, NY

---- 13 Philadelphia
1101 13 Philadelphia, PA
1108 13 Philadelphia Airport, PA

---- 14 Other Delaware River Ports
1100 14 Philadelphia, PA CD
1102 14 Chester, PA
1103 14 Wilmington, Del.
1105 14 Paulsboro, NJ
1107 14 Camden, NJ
1113 14 Gloucester City, NJ
1118 14 Marcus Hook, PA

---- 15 Baltimore
1303 15 Baltimore, MD

---- 16 Other Chesapeake Bay Ports
1300 16 Baltimore, MD CD
1301 16 Annapolis, MD
1302 16 Cambridge, MD
1304 16 Crisfield, MD
1305 16 Washington, DC
1405 16 Alexandria, VA
1406 16 Cape Charles City, VA
1407 16 Reedville, VA
5400 16 Washington, DC CD
5401 16 Washington, DC
5402 16 Alexandria, VA

---- 17 Norfolk
1401 17 Norfolk, VA

---- 18 Other Hampton Roads Ports
1400 18 Norfolk, VA CD
1402 18 Newport News, VA
1403 18 Petersburg, VA
1404 18 Richmond-Petersburg, VA
1408 18 Hopewell, VA

---- 19 Other North Atlantic Ports
0100 19 Portland, Maine CD
0101 19 Portland, Maine
0103 19 Eastport, Maine
0111 19 Bath, Maine
0112 19 Bar Harbor, Maine
0115 19 Calais, Maine
0121 19 Rockland, Maine
```

0122 19 Jonesport, Maine
0131 19 Portsmouth, NH
0132 19 Belfast, Maine
0152 19 Searsport, Maine
0400 19 Boston, Mass. CD
0402 19 Springfield, Mass.
0403 19 Worcester, Mass.
0404 19 Gloucester, Mass.
0405 19 New Bedford, Mass.
0406 19 Plymouth, Mass.
0407 19 Fall River, Mass.
0408 19 Salem, Mass.
0409 19 Provincetown, Mass.
0416 19 Lawrence, Mass.
0500 19 Providence, RI CD
0501 19 Newport, RI
0502 19 Providence, RI
0503 19 Mellville, RI
0600 19 Bridgeport, Conn. CD
0601 19 Bridgeport, Conn.
0602 19 Hartford, Conn.
0603 19 New Haven, Conn.
0604 19 New London, Conn.
1002 19 Albany, NY

---- 21 Wilmington, NC
1501 21 Wilmington, NC

---- 22 Charleston
1601 22 Charleston, SC

---- 23 Savannah
1703 23 Savannah, GA

---- 24 Jacksonville
1803 24 Jacksonville, Fla.

---- 25 Miami
5201 25 Miami, Fla.
5206 25 Miami Airport, Fla.

---- 26 Other South Florida Ports
5200 26 Miami, Fla. CD
5203 26 Port Everglades, Fla.
5204 26 West Palm Beach, Fla.
5205 26 Fort Pierce, Fla.
5202 26 Key West, Fla.

---- 27 Puerto Rico/Virgin Islands
4900 27 San Juan, PR CD
4901 27 Aguadilla, PR
4904 27 Fajardo, PR
4905 27 Guanica, PR
4906 27 Humacao, PR
4907 27 Mayaguez, PR
4908 27 Ponce, PR
4909 27 San Juan, PR
4911 27 Jobos, PR
4912 27 Guayanilla, PR

4913 27 San Juan Airport, PR
5100 27 Charlotte Amalie, VI CD
5101 27 Charlotte Amalie, VI
5102 27 Cruz Bay, VI
5103 27 Coral Bay, VI
5104 27 Christiansted, VI
5105 27 Frederiksted, VI

---- 28 Other South Atlantic Ports
1500 28 Wilmington, NC CD
1600 28 Charleston, SC CD
1700 28 Savannah, GA CD
1502 28 Winston-Salem, NC
1503 28 Durham, NC
1506 28 Reidsville, NC
1508 28 Elizabeth City, NC
1510 28 Elkin, NC
1511 28 Beaufort-Morhead City, NC
1512 28 Charlotte, NC
1602 28 Georgetown, SC
1603 28 Greenville, SC
1604 28 Columbia, SC
1701 28 Brunswick, GA
1704 28 Atlanta, GA
1805 28 Fernandina Beach, Fla.
1808 28 Orlando, Fla.
1809 28 St. Augustine, Fla.
1816 28 Port Canaveral, Fla.

---- 31 Tampa/St. Petersburg
1800 31 Tampa, Fla. CD
1801 31 Tampa, Fla.
1807 31 Bocagrande, Fla.
1814 31 St. Petersburg, Fla.

---- 32 Mobile
1901 32 Mobile, Ala.

---- 33 Other Central Gulf Ports
1806 33 Carabelle, Fla.
1817 33 Apalachicola, Fla.
1818 33 Panama City, Fla.
1819 33 Pensacola, Fla.
1820 33 Port St. Joe, Fla.
1900 33 Mobile, Ala. CD
1902 33 Gulfport, Miss.
1903 33 Pascagoula, Miss.
1904 33 Birmingham, Ala.
1905 33 Apalachicola, Fla.
1906 33 Carrabelle, Fla.
1907 33 Panama City, Fla.
1908 33 Pensacola, Fla.
1909 33 Port St. Joe, Fla.

---- 34 New Orleans
2002 34 New Orleans, LA

---- 35 Mississippi River System Ports
2000 35 New Orleans, LA CD
2001 35 Morgan City, LA
2003 35 Little Rock, Ark.
2004 35 Baton Rouge, LA
2005 35 Port Sulphur, LA
2006 35 Memphis, Tenn.
2007 35 Nashville, Tenn.
2008 35 Chattanooga, Tenn.
2009 35 Destrehan, LA
2010 35 Gramercy, LA
2011 35 Greenville, Miss.
2012 35 Avondale, LA
2013 35 St. Rose, LA
2014 35 Good Hope, LA
2015 35 Vicksburg, Miss.
2016 35 Knoxville, Tenn.
3500 35 Minneapolis, Minn. CD
3501 35 St. Paul, Minn.
4102 35 Cincinnati Ohio
4113 35 Evansville, Ind.
4115 35 Louisville, Kentucky
4116 35 Owensboro-Evansville, Ind.
4500 35 St. Louis, Mo. CD
4501 35 Kansas City, Mo.
4502 35 St Joseph, Mo.
4503 35 St. Louis, Mo.
4504 35 Witchita, Kan.

---- 36 Lake Charles/Beaumont/Port Arthur
2017 36 Lake Charles, LA
2100 36 Port Arthur, Texas CD
2101 36 Port Arthur, Texas
2102 36 Sabine, Texas
2103 36 Orange, Texas
2104 36 Beaumont, Texas
2105 36 Lake Charles, LA

---- 37 Houston/Galveston
2200 37 Galveston, Texas CD
2201 37 Galveston, Texas
2206 37 Texas City, Texas
5300 37 Houston, Texas CD
5301 37 Houston, Texas
5310 37 Galveston, Texas

---- 38 Corpus Christi
2205 38 Corpus Christi, Texas
5312 38 Corpus Christi, Texas

---- 39 Other West Gulf Ports
2204 39 Freeport, Texas
2208 39 Port Lavaca, Texas
2301 39 Brownsville, Texas
5311 39 Freeport, Texas
5313 39 Port Lavaca, Texas

---- 41 Lake Michigan Ports
3700 41 Milwaukee, Wis. CD
3701 41 Milwaukee, Wis.
3702 41 Marinette, Wis.
3703 41 Green Bay, Wis.
3706 41 Manitowoc, Wis.
3707 41 Sheboygan, Wis.
3708 41 Racine, Wis.
3806 41 Grand Rapids, MI
3808 41 Escanaba, MI
3815 41 Muskegon, MI
3816 41 Grand Haven, MI
3822 41 South Haven, MI
3844 41 Ferrysburg, MI
3900 41 Chicago, Ill. CD
3901 41 Chicago, Ill.
3904 41 East Chicago, Ind.
3905 41 Gary, Ind.
3906 41 O'Hare Airport, Ill.

---- 42 Lake Erie Ports
3800 42 Detroit, MI CD
3801 42 Detroit, MI
4100 42 Cleveland, Ohio CD
4101 42 Cleveland, Ohio
4105 42 Toledo, Ohio
4106 42 Erie, PA
4107 42 Sandusky, Ohio
4108 42 Ashtabula, Ohio
4109 42 Conneaut, Ohio
4111 42 Fairport, Ohio
4114 42 Lawrenceburg, Ind.
4117 42 Huron, Ohio
4121 42 Lorain, Ohio
4122 42 Ashtabula/Conneaut, Ohio

---- 43 Other Great Lakes Ports
0700 43 Ogdensburg, NY CD
0701 43 Ogdensburg, NY
0704 43 Massena, NY
0705 43 Fort Covington, NY
0706 43 Cape Vincent, NY
0707 43 Morristown, NY
0708 43 Alexandria Bay, NY
0711 43 Chateaugay, NY
0712 43 Champlain - Rouses Point, NY
0713 43 Waddington, NY
0714 43 Clayton, NY
0715 43 Trout River, NY
0900 43 Buffalo-Niagara Falls, NY CD
0901 43 Buffalo, NY
0903 43 Rochester, NY
0904 43 Oswego, NY
0905 43 Sodus Point, NY
0906 43 Syracuse, NY
0907 43 Utica, NY
3600 43 Duluth, Minn. CD
3601 43 Duluth, Minn.

3602 43 Ashland, Wis.
3608 43 Superior, Wis.
3613 43 Grand Portage, Minn.
3614 43 Silver Bay, Minn.
3802 43 Port Huron, MI
3803 43 Sault Ste. Marie, MI
3804 43 Saginaw-Bay Cty-Flint, MI
3805 43 Battle Creek, MI
3809 43 Marquette, MI
3814 43 Algonac, MI
3818 43 Rogers City, MI
3819 43 De Tour, MI
3820 43 Mackinac Island, MI
3842 43 Presque Isle, MI
3843 43 Alpena, MI

---- 51 Long Beach/Los Angeles
2700 51 Los Angeles, Calif. CD
2704 51 Los Angeles, Calif.
2709 51 Long Beach, Calif.
2720 51 Los Angeles Airport, Calif.

---- 52 Other Southern California Ports
2500 52 San Diego, Calif. CD
2501 52 San Diego, Calif.
2504 52 San Ysidro, Calif.
2707 52 Port San Luis, Calif.
2711 52 El Segundo, Calif.
2712 52 Ventura, Calif.
2713 52 Port Hueneme, Calif.
2719 52 Morro, Calif.

---- 53 Oakland/San Francisco
2801 53 San Francisco Airport, Calif.
2809 53 San Francisco, Calif.
2811 53 Oakland, Calif.

---- 54 Other San Francisco Bay
2800 54 San Francisco, Calif. CD
2810 54 Stockton, Calif.
2812 54 Richmond, Calif.
2813 54 Alameda, Calif.
2815 54 Crockett, Calif.
2816 54 Sacramento, Calif.
2820 54 Martinez, Calif.
2821 54 Redwood City, Calif.
2827 54 Selby, Calif.
2828 54 San Joaquin River, Calif.
2829 54 San Pablo Bay, Calif.
2830 54 Carquinez Strait, Calif.
2831 54 Suisun Bay, Calif.

---- 55 Other Northern California Ports
2802 55 Eureka, Calif.
2805 55 Monterey, Calif.

---- 56 Honolulu/Hawaii Ports
3200 56 Honolulu, Hawaii CD
3201 56 Honolulu, Hawaii
3202 56 Hilo, Hawaii
3203 56 Kahului, Hawaii
3204 56 Nawilili-Pt Allen, Hawaii
3205 56 Honolulu Airport, Hawaii

---- 61 Portland, OR
2904 61 Portland, Oregon

---- 62 Other Columbia River Ports
2900 62 Portland, Oregon CD
2901 62 Astoria, Oregon
2905 62 Longview, Wash.
2908 62 Vancouver, Wash.
2909 62 Kalama, Wash.

---- 63 Seattle/Tacoma
3001 63 Seattle, Wash.
3002 63 Tacoma, Wash.
3029 63 Seattle Airport, Wash.

---- 64 Other Puget Sound Ports
3000 64 Seattle, Wash. CD
3004 64 Blaine, Wash.
3005 64 Bellingham, Wash.
3006 64 Everett, Wash.
3007 64 Port Angeles, Wash.
3008 64 Port Townsend, Wash.
3010 64 Anacortes, Wash.
3014 64 Friday Harbor, Wash.
3017 64 Point Roberts, Wash.
3026 64 Olympia, Wash.

---- 65 Other Pacific Northwest Ports
2902 65 Newport, Oregon
2903 65 Coos Bay, Oregon
3003 65 Aberdeen-Hoquiam, Wash.
3021 65 South Bend-Raymond, Wash
3027 65 Neah Bay, Wash.

---- 66 Alaska Ports
3100 66 Anchorage, Alaska CD
3101 66 Juneau, Alaska
3102 66 Ketchikan, Alaska
3103 66 Skagway, Alaska
3104 66 Alcan, Alaska
3105 66 Wrangell, Alaska
3106 66 Dalton Cache, Alaska
3107 66 Valdez, Alaska
3111 66 Fairbanks, Alaska
3112 66 Petersburg, Alaska
3115 66 Sitka, Alaska
3124 66 Pelican, Alaska
3125 66 Sand Point, Alaska
3126 66 Anchorage, Alaska
3127 66 Kodiak, Alaska

---- 99 Land-Locked Ports - Ignore if Encountered
0102 99 Bangor, Maine
0104 99 Jackman, Maine
0105 99 Vanceboro, Maine
0106 99 Houlton, Maine
0107 99 Fort Fairfield, Maine
0108 99 Van Buren, Maine
0109 99 Madawaska, Maine
0110 99 Fort Kent, Maine
0118 99 Limestone, Maine
0127 99 Bridgewater, Maine
0200 99 St. Albans, Vermont CD
0201 99 St. Albans, Vermont
0202 99 Newport, Vermont
0203 99 Richford, Vermont
0204 99 Island Pond, Vermont
0205 99 Alburg, Vermont
0206 99 Beecher Falls, Vermont
0207 99 Burlington, Vermont
0208 99 North Troy, Vermont
0209 99 Derby Line, Vermont
0210 99 Highgate Springs, Vermont
0211 99 Norton, Vermont
1104 99 Pittsburg, PA
1106 99 Wilkes-Barre/Scranton, PA
1109 99 Harrisburg, PA
1409 99 Charleston, WV
2300 99 Laredo, Texas CD
2302 99 Del Rio, Texas
2303 99 Eagle Pass, Texas
2304 99 Laredo, Texas
2305 99 Hidalgo, Texas
2307 99 Rio Grande City, Texas
2308 99 San Antonio, Texas
2309 99 Progresso, Texas
2310 99 Roma, Texas
2400 99 El Paso, Texas CD
2402 99 El Paso, Texas
2403 99 Presidio, Texas
2404 99 Fabens, Texas
2405 99 Denver, Colo.
2406 99 Columbus, NM
2407 99 Albuquerque, NM
2502 99 Andrade, Calif.
2503 99 Calexico, Calif.
2505 99 Tecate, Calif.
2715 99 Capitan, Calif.
2600 99 Nogales, AZ CD
2601 99 Douglas, AZ
2602 99 Lukeville, AZ
2603 99 Naco, AZ
2604 99 Nogales, AZ
2605 99 Phoenix, AZ
2606 99 Sasabe, AZ
2608 99 San Luis, AZ
2722 99 Las Vegas, NV
2803 99 Fresno, Calif.
2832 99 Salt Lake City, Utah
2833 99 Reno, NV

2907 99 Boise, ID
3009 99 Sumas, Wash.
3011 99 Nighthawk Wash.
3012 99 Danville Wash.
3013 99 Ferry, Wash.
3015 99 Boundary, Wash.
3016 99 Laurier, Wash.
3019 99 Oroville, Wash.
3020 99 Frontier, Wash.
3022 99 Spokane, Wash.
3023 99 Lynden, Wash.
3025 99 Metaline Falls, Wash.
3300 99 Great Falls, Montana CD
3301 99 Raymond, Montana
3302 99 Eastport, Idaho
3303 99 Salt Lake City, Utah
3304 99 Great Falls, Montana
3305 99 Butte, Montana
3306 99 Turner, Montana
3307 99 Denver, Colorado
3308 99 Porthill, Idaho
3309 99 Scobey, Montana
3310 99 Sweetgrass, Montana
3312 99 Whitetail, Montana
3316 99 Piegan, Montana
3317 99 Opheim, Montana
3318 99 Roosville, Montana
3319 99 Morgan, Montana
3321 99 Whitlash, Montana
3322 99 Del Bonita, Montana
3400 99 Pembina, ND CD
3401 99 Pembina, ND
3402 99 Noyes, Minn.
3403 99 Portal, ND
3404 99 Neche, ND
3405 99 St John, ND
3406 99 Northgate, ND
3407 99 Walhalla, ND
3408 99 Hannah, ND
3409 99 Sarles, ND
3410 99 Ambrose, ND
3413 99 Antler, ND
3414 99 Sherwood, ND
3415 99 Hansboro, ND
3416 99 Maida, ND
3417 99 Fortuna, ND
3419 99 Westhope, ND
3420 99 Noonan, ND
3421 99 Carbury, ND
3422 99 Dunseith, ND
3423 99 Warroad, Minn.
3424 99 Baudette, Minn.
3425 99 Pinecreek, Minn.
3426 99 Roseau, Minn.
3604 99 Intl. Falls-Ranier, Minn.
3902 99 Peoria, Ill.
3903 99 Omaha, Neb.
3907 99 Des Moines, Iowa
4103 99 Columbus, Ohio

4104 99 Dayton, Ohio
4110 99 Indianapolis, Ind.
4112 99 Akron, Ohio
5302 99 Dallas, Texas
5303 99 Fort Worth, Texas
5304 99 Oklahoma City, Okla.
5305 99 Tulsa, Okla.
5306 99 Dallas-Fort Worth, Texas
5307 99 Amarillo, Texas
5308 99 Lubbock, Texas
5500 99 Dallas/Fort Worth, Texas CD

APPENDIX TABLE 4

```
--- 01 Europe
101 01 Greenland
400 01 Iceland
401 01 Sweden
403 01 Norway
405 01 Finland
409 01 Denmark
412 01 United Kingdom
418 01 Northern Ireland
419 01 Ireland
421 01 Netherlands
423 01 Belgium/Luxembourg
427 01 France
428 01 West Germany
429 01 German Dem. Republic
430 01 Monaco
433 01 Austria
435 01 Czechoslovakia
437 01 Hungary
441 01 Switzerland
447 01 Estonia
449 01 Latvia
451 01 Lithuania
455 01 Poland
461 01 Soviet Union
467 01 Azores
469 01 Spain (obsolete)
470 01 Spain
471 01 Portugal
472 01 Gibraltar
473 01 Malta And Gozo
475 01 Italy
479 01 Yugoslavia
481 01 Albania
484 01 Greece
485 01 Romania
487 01 Bulgaria
489 01 Turkey
491 01 Cyprus

--- 02 East and South Asia
533 02 India
535 02 Pakistan
536 02 Nepal
538 02 Bangladesh
542 02 Sri Lanka (Ceylon)
546 02 Burma
549 02 Thailand
550 02 North Vietnam
551 02 South Vietnam
552 02 Vietnam
553 02 Laos
555 02 Cambodia
557 02 Malaysia
559 02 Singapore
560 02 Indonesia
561 02 Brunei
565 02 Philippines
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566 02 Macao
567 02 Timor & SSE Asia
568 02 Southern Asia NEC
570 02 China (PRC)
574 02 Mongolia
579 02 North Korea
580 02 Republic Of Korea
582 02 Hong Kong
583 02 Taiwan
588 02 Japan
590 02 Nansei Islands

--- 03 Australia/Oceania
602 03 Australia
604 03 Papua New Guinea
614 03 New Zealand
615 03 Western Samoa
622 03 Southern Pacific Islands
631 03 Fiji
632 03 Togo
633 03 Tonga
634 03 Vanuatu
641 03 French Pacific Islands
684 03 Trust Pacific Islands
685 03 Other Pacific Isl. NEC
686 03 Other Pacific Isl. NEC
931 03 Midway Island
933 03 Wake Island
935 03 Guam
941 03 Canton And Enderbury Isl.
951 03 American Somoa

--- 04 Africa/Middle East
502 04 Syria
504 04 Lebanon
505 04 Iraq
507 04 Iran
508 04 Israel
511 04 Jordan
512 04 Gaza Strip
513 04 Kuwait
517 04 Saudi Arabia
518 04 Qatar
520 04 United Arab Emirates
521 04 Yemen (Sana)
522 04 Yemen (Aden)
523 04 Oman
525 04 Bahrain
531 04 Afghanistan
714 04 Morocco
721 04 Algeria
723 04 Tunisia
725 04 Libya
729 04 Egypt
732 04 Sudan
733 04 Canary Islands
735 04 Spanish Africa NEC
736 04 Spanish Africa NEC
737 04 Western Sahara
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738 04 Equatorial Guinea
741 04 Mauritania
742 04 Cameroon
744 04 Senegal
745 04 Mali
746 04 Guinea
747 04 Sierra Leone
748 04 Ivory Coast
749 04 Ghana
750 04 Gambia
751 04 Niger
752 04 Togo
753 04 Nigeria
754 04 Central African Republic
755 04 Gabon
756 04 Chad
757 04 Western Africa NEC
758 04 St. Helena
759 04 Madeira Islands
760 04 Upper Volta
761 04 Benin
762 04 Angola
763 04 Congo (Brazziville)
764 04 Western Africa NEC
765 04 Liberia
766 04 Zaire
767 04 Burundi
769 04 Rwanda
770 04 Somalia
774 04 Ethiopia
777 04 Djibouti
778 04 Uganda
779 04 Kenya
780 04 Seychelles
781 04 British Indian Ocean
782 04 Seychelles (Obsolete)
783 04 Tanzania
784 04 Mauritius (Obsolete)
785 04 Mauritius
787 04 Mozambique
788 04 Malagasy Republic
789 04 Comoros
790 04 French Indian Ocean
791 04 South Africa
792 04 Namibia
793 04 Botswana
794 04 Zambia
795 04 Swaziland
796 04 Zimbabwe
797 04 Malawi
799 04 Lesotho

--- 05 Latin America
201 05 Mexico
205 05 Guatemala
208 05 Belize
211 05 El Salvador
215 05 Honduras
219 05 Nicaragua
```

223 05 Costa Rica
225 05 Panama
227 05 Canal Zone
232 05 Bermuda
236 05 Bahamas
239 05 Cuba
241 05 Jamaica
242 05 Jamaica, Caicos And Caymans
243 05 Turks And Caicos Isl.
244 05 Cayman Islands
245 05 Haiti
247 05 Dominican Republic
248 05 Leeward And Windward Isl.
272 05 Barbados
274 05 Trinidad And Tobago
277 05 Netherlands Antilles
283 05 French West Indies
301 05 Colombia
307 05 Venezuela
312 05 Guyana
315 05 Surinam
317 05 French Guiana
331 05 Ecuador
333 05 Peru
335 05 Bolivia
337 05 Chile
351 05 Brazil
353 05 Paraguay
355 05 Uruguay
357 05 Argentina
372 05 Falkland Islands
903 05 Puerto Rico
911 05 Virgin Islands

--- 06 Canada
122 06 Canada
161 06 St. Pierre And Miquelon
822 06 U.S. Grain Transshipped Through Canada

Appendix Table 5

U.S. LINER CONTAINER TRADES BY
(SHORT TONS)

		IMPORTS			
		1986	1987	1986	1987
U.S. PORT	FOREIGN REGION	TONS	TONS	TEUS	TEUS
ATLANTIC COAST	EUROPE	8968812	8941634	789111	775449
ATLANTIC COAST	EAST AND SOUTH ASIA	5024857	4778158	595764	571386
ATLANTIC COAST	AUSTRALIA/OCEANIA	514537	489279	47545	45625
ATLANTIC COAST	AFRICA/MIDDLE EAST	708210	613219	54752	48975
ATLANTIC COAST	LATIN AMERICA	2675158	2804489	264183	272048
ATLANTIC COAST	CANADA	31394	182846	3246	10140
ATLANTIC COAST	TOTAL	17922968	17809625	1754601	1723623
GULF COAST	EUROPE	1331056	1217265	105812	98752
GULF COAST	EAST AND SOUTH ASIA	180916	135609	13514	12204
GULF COAST	AUSTRALIA/OCEANIA	37651	43045	3410	3907
GULF COAST	AFRICA/MIDDLE EAST	174706	109551	12345	8448
GULF COAST	LATIN AMERICA	867662	1126849	112465	136366
GULF COAST	CANADA	1080	3124	103	162
GULF COAST	TOTAL	2593071	2635443	247649	259839
PACIFIC COAST	EUROPE	1365792	1529918	115499	123566
PACIFIC COAST	EAST AND SOUTH ASIA	12167257	12823405	1756967	1830435
PACIFIC COAST	AUSTRALIA/OCEANIA	464042	558777	42113	49123
PACIFIC COAST	AFRICA/MIDDLE EAST	107616	170078	7889	11440
PACIFIC COAST	LATIN AMERICA	226985	342704	18315	25971
PACIFIC COAST	CANADA	25751	65545	2120	3958
PACIFIC COAST	TOTAL	14357443	15490427	1942903	2044493

Source: Manalytics Waterborne Trade Database

MAJOR PORT

		EXPORTS							
1986	1987	1986	1987	1986	1987	1986	1987		
FEUS	FEUS	TONS	TONS	TEUS	TEUS	FEUS	FEUS		
472595	468401	4157651	4441888	330493	353891	198326	212987		
315167	301840	4161670	4247346	289574	297989	192300	196764		
25131	23896	196514	256447	15933	20529	9505	12391		
35168	30850	923930	1000794	82214	88440	46362	50207		
145301	150804	1422080	1630200	115828	134107	69438	79752		
1798	8446	6826	9394	504	661	321	432		
995160	984237	10868671	11586069	834546	895617	516252	552533		
67443	62125	1773288	2218117	127879	162212	82035	102624		
9058	7424	834932	958506	57215	66566	38031	43809		
1817	2084	85077	130725	5954	8700	3942	6026		
8349	5422	776105	853102	53603	59352	35819	39477		
54406	68031	1098033	1250473	73741	85365	50533	57542		
60	141	444	257	30	26	19	12		
141133	145227	4567879	5411180	318422	382221	210379	249490		
71381	78503	810527	900231	65351	73545	38563	43244		
871448	911038	11131182	13404136	847152	1019848	519539	626740		
22948	27259	526705	604233	41561	47366	25039	28757		
5370	8299	124966	160617	10417	12764	6006	7778		
11190	16335	163872	145731	11468	10865	7605	6837		
1285	3037	21973	18036	1364	1470	1022	860		
983622	1044471	12779225	15232984	977313	1165858	597774	714216		

U.S. LINER

U.S. PORT	FOREIGN REGION	1986 TONS
GREAT LAKES	EUROPE	29457
GREAT LAKES	EAST AND SOUTH ASIA	4176
GREAT LAKES	AUSTRALIA/OCEANIA	135
GREAT LAKES	AFRICA/MIDDLE EAST	1312
GREAT LAKES	LATIN AMERICA	1827
GREAT LAKES	CANADA	1023
GREAT LAKES	TOTAL	37930
HAWAII/ALASKA/PUERTO RICO	EUROPE	203147
HAWAII/ALASKA/PUERTO RICO	EAST AND SOUTH ASIA	99577
HAWAII/ALASKA/PUERTO RICO	AUSTRALIA/OCEANIA	36653
HAWAII/ALASKA/PUERTO RICO	AFRICA/MIDDLE EAST	5590
HAWAII/ALASKA/PUERTO RICO	LATIN AMERICA	199145
HAWAII/ALASKA/PUERTO RICO	CANADA	15352
HAWAII/ALASKA/PUERTO RICO	TOTAL	559464
BOSTON	EUROPE	283172
BOSTON	EAST AND SOUTH ASIA	3626
BOSTON	AUSTRALIA/OCEANIA	434
BOSTON	AFRICA/MIDDLE EAST	4371
BOSTON	LATIN AMERICA	6342
BOSTON	CANADA	88
BOSTON	TOTAL	298033

Source: Manalytics Waterborne Trade Database

Appendix Table 5

CONTAINER TRADES BY MAJOR PORT (SHORT TONS)

IMPORTS					EXPORTS					
1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS	1986 TONS	1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS
27739	2199	1849	1451	1316	5376	2943	359	230	258	138
3421	329	294	216	179	66920	11931	4379	800	3041	542
1594	13	79	6	72	26	70	2	6	1	3
1427	71	128	59	74	75647	43740	4663	2991	3452	2002
32	171	4	83	2	14628	299	950	17	685	13
1117	57	64	47	51	5834	2139	337	169	265	97
35330	2840	2418	1862	1694	168431	61122	10690	4213	7702	2795
184322	14429	13291	9900	8974	19222	33235	1606	2788	925	1583
117439	12962	14702	6617	7637	77640	83878	6648	6518	3726	3944
29318	2919	2460	1727	1408	2367	893	155	103	110	48
8721	451	512	272	402	3980	7713	304	661	187	356
220266	20308	20829	10967	11700	120369	91486	9600	7243	5759	4459
10928	1296	911	745	528	1894	2359	130	199	92	123
570994	52365	52705	30228	30649	225472	219564	18443	17512	10799	10513
298912	25938	26729	15259	15859	61775	79639	5264	6687	3001	3848
10627	437	2225	217	1060	1023	4800	68	341	46	219
2960	47	306	22	154	9	431	1	33	0	19
3930	364	307	217	194	1557	2268	163	193	78	104
7904	661	621	370	386	938	1170	53	66	41	52
20	13	1	6	0	0	1	0	0	0	0
324353	27460	30189	16091	17653	65302	88309	5549	7320	3166	4242

U.S. LINER

U.S. PORT	FOREIGN REGION	1986 TONS
NEW YORK	EUROPE	4289429
NEW YORK	EAST AND SOUTH ASIA	2688524
NEW YORK	AUSTRALIA/OCEANIA	26340
NEW YORK	AFRICA/MIDDLE EAST	302452
NEW YORK	LATIN AMERICA	785523
NEW YORK	CANADA	13037
NEW YORK	TOTAL	8105305
PHILADELPHIA	EUROPE	234332
PHILADELPHIA	EAST AND SOUTH ASIA	29242
PHILADELPHIA	AUSTRALIA/OCEANIA	14728
PHILADELPHIA	AFRICA/MIDDLE EAST	63593
PHILADELPHIA	LATIN AMERICA	171856
PHILADELPHIA	CANADA	1171
PHILADELPHIA	TOTAL	514922
OTHER DELAWARE RIVER PORTS	EUROPE	86066
OTHER DELAWARE RIVER PORTS	EAST AND SOUTH ASIA	1102
OTHER DELAWARE RIVER PORTS	AUSTRALIA/OCEANIA	330479
OTHER DELAWARE RIVER PORTS	AFRICA/MIDDLE EAST	4264
OTHER DELAWARE RIVER PORTS	LATIN AMERICA	219642
OTHER DELAWARE RIVER PORTS	CANADA	7
OTHER DELAWARE RIVER PORTS	TOTAL	641560

Source: Manalytics Waterborne Trade Database

Appendix Table 5

R CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

---------- IMPORTS					---------- EXPORTS					
1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS	1986 TONS	1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS
4114158	391470	372245	232188	222476	872581	768464	73404	65832	42716	37883
2419236	329031	299412	172320	156557	1211959	1168842	90458	87404	56056	54094
29306	2307	2484	1328	1460	38560	47326	3284	3991	1907	2333
232979	24391	20765	15402	12312	283577	273849	26272	24892	14331	13704
740932	73093	69035	41825	39517	320755	287270	26425	23504	15705	14062
54891	1303	3425	705	2574	376	63	25	4	18	2
7591502	821595	767366	463768	434896	2727808	2545814	219868	205627	130733	122078
152933	19660	12914	12019	7806	54635	43913	3973	3177	2588	2062
12866	2516	1098	1502	660	30462	3713	2116	219	1416	167
8227	1460	785	718	396	875	1300	81	146	45	76
53307	4511	3998	2904	2487	3358	1915	235	137	152	88
301278	13827	24865	8703	15137	26177	90928	1773	6930	1239	4346
91	76	8	54	4	662	157	44	10	32	7
528702	42050	43668	25900	26490	116169	141926	8222	10619	5472	6746
177133	6848	14742	4356	9193	27368	42768	2172	3233	1319	2046
49320	83	4966	51	2815	1214	20775	68	1577	54	946
327743	31904	30844	16151	15900	35601	32185	2765	2350	1757	1573
64034	329	3341	224	2925	854	1622	59	194	38	100
258044	33548	35575	15201	16811	8440	16735	672	1367	402	812
1117	1	55	0	50	0	3	0	0	0	0
877391	72713	89523	35983	47694	73477	114088	5736	8721	3570	5477

U.S. LINE[illegible]

U.S. PORT	FOREIGN REGION	1986 TONS
BALTIMORE	EUROPE	1052544
BALTIMORE	EAST AND SOUTH ASIA	539077
BALTIMORE	AUSTRALIA/OCEANIA	20858
BALTIMORE	AFRICA/MIDDLE EAST	115067
BALTIMORE	LATIN AMERICA	286164
BALTIMORE	CANADA	10314
BALTIMORE	TOTAL	2024024
OTHER CHESAPEAKE BAY PORTS	EUROPE	0
OTHER CHESAPEAKE BAY PORTS	EAST AND SOUTH ASIA	0
OTHER CHESAPEAKE BAY PORTS	AFRICA/MIDDLE EAST	0
OTHER CHESAPEAKE BAY PORTS	LATIN AMERICA	0
OTHER CHESAPEAKE BAY PORTS	CANADA	0
OTHER CHESAPEAKE BAY PORTS	TOTAL	0
NORFOLK	EUROPE	941868
NORFOLK	EAST AND SOUTH ASIA	180371
NORFOLK	AUSTRALIA/OCEANIA	44784
NORFOLK	AFRICA/MIDDLE EAST	47715
NORFOLK	LATIN AMERICA	96882
NORFOLK	CANADA	2304
NORFOLK	TOTAL	1313924

Source: Manalytics Waterborne Trade Database

Appendix Table 5

R CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

IMPORTS					EXPORTS					
1987	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987
TONS	TEUS	TEUS	FEUS	FEUS	TONS	TONS	TEUS	TEUS	FEUS	FEUS
1084212	91522	92135	54698	56162	624589	695733	47428	52990	29858	33395
450349	56324	49327	31521	27031	396842	325511	26674	22615	18308	15117
9095	1075	461	948	413	2743	5252	210	441	131	266
96708	8032	6797	5603	4708	163631	205520	14089	18585	8288	10591
218638	24994	18132	14553	10957	133429	128972	10173	9295	6507	6133
1398	928	102	580	72	114	534	7	51	4	24
1860400	182875	166954	107903	99343	1321348	1361522	98581	103977	63096	65526
40	0	2	0	1	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
98	0	10	0	4	0	0	0	0	0	0
0	0	0	0	0	0	11	0	0	0	0
0	0	0	0	0	0	25	0	1	0	1
139	0	12	0	5	0	36	0	1	0	1
966237	81247	83233	47878	48382	666994	759306	56834	64147	32004	36665
304804	18675	29083	10366	17037	364948	465466	26112	33995	16999	21723
34769	3416	3143	2133	1712	64953	85236	5386	6974	3121	4112
46760	3974	3774	2379	2343	85536	102947	8167	9824	4401	5320
109277	11327	11492	5502	5910	45354	34776	3270	2593	2128	1644
661	285	72	136	34	1185	3892	93	282	56	177
1462508	118924	130797	68394	75418	1228970	1451623	99862	117815	58709	69641

U.S. LINER

U.S. PORT	FOREIGN REGION	1986 TONS
OTHER HAMPTON ROADS PORTS	EUROPE	51364
OTHER HAMPTON ROADS PORTS	EAST AND SOUTH ASIA	1250
OTHER HAMPTON ROADS PORTS	AUSTRALIA/OCEANIA	21
OTHER HAMPTON ROADS PORTS	AFRICA/MIDDLE EAST	4389
OTHER HAMPTON ROADS PORTS	LATIN AMERICA	6016
OTHER HAMPTON ROADS PORTS	CANADA	0
OTHER HAMPTON ROADS PORTS	TOTAL	63040
OTHER NORTH ATLANTIC PORTS	EUROPE	19615
OTHER NORTH ATLANTIC PORTS	EAST AND SOUTH ASIA	419
OTHER NORTH ATLANTIC PORTS	AUSTRALIA/OCEANIA	30
OTHER NORTH ATLANTIC PORTS	AFRICA/MIDDLE EAST	28098
OTHER NORTH ATLANTIC PORTS	LATIN AMERICA	69917
OTHER NORTH ATLANTIC PORTS	CANADA	0
OTHER NORTH ATLANTIC PORTS	TOTAL	118079
WILMINGTON, NC	EUROPE	114928
WILMINGTON, NC	EAST AND SOUTH ASIA	53775
WILMINGTON, NC	AUSTRALIA/OCEANIA	19
WILMINGTON, NC	AFRICA/MIDDLE EAST	2423
WILMINGTON, NC	LATIN AMERICA	11816
WILMINGTON, NC	CANADA	3254
WILMINGTON, NC	TOTAL	186215

Source: Manalytics Waterborne Trade Database

Appendix Table 5

CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

IMPORTS					EXPORTS					
1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS	1986 TONS	1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS
65991	4187	5356	2574	3357	103933	99529	8660	9232	5077	5030
2006	114	242	69	130	4400	8848	336	715	197	405
0	1	0	0	0	89	93	8	9	3	4
4303	353	403	219	225	38099	13183	3331	1202	1884	663
2511	765	273	364	139	739	2047	65	123	35	94
33	0	7	0	3	8	0	0	0	0	0
74844	5420	6281	3226	3854	147268	123700	12400	11281	7196	6196
26462	1235	2188	907	1291	19089	22814	1445	1678	889	1055
42	29	4	19	2	1	19	0	1	0	0
30	3	3	1	1	0	0	0	0	0	0
39	1423	3	1280	2	138	1	9	0	5	0
5844	3601	437	3178	284	1759	3433	128	250	78	155
2	0	0	0	0	251	1224	23	121	11	59
32419	6291	2635	5385	1580	21238	27491	1605	2050	983	1269
89712	10670	8291	6196	4847	224683	221204	18985	18604	10639	10460
62243	7323	8577	3677	4307	153052	152119	11568	11011	7115	7042
91	1	7	0	4	342	54	36	3	17	2
366	188	28	113	18	23597	13518	1802	976	1108	633
26829	1535	3507	729	1632	834	345	62	26	38	15
10382	516	702	245	509	2308	205	203	20	109	9
189623	20233	21112	10960	11317	404816	387445	32656	30640	19026	18161

Appendix Table 5

U.S. LINER CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

		IMPORTS						EXPORTS					
		1986	1987	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987
U.S. PORT	FOREIGN REGION	TONS	TONS	TEUS	TEUS	FEUS	FEUS	TONS	TONS	TEUS	TEUS	FEUS	FEUS
CHARLESTON	EUROPE	846001	940036	71915	77267	43098	47168	667009	770018	48776	56987	31210	36200
CHARLESTON	EAST AND SOUTH ASIA	516889	693888	59719	79581	31674	42413	1203971	1335866	79484	88668	55456	61818
CHARLESTON	AUSTRALIA/OCEANIA	62157	64328	6031	6373	3119	3225	46209	62767	3651	4881	2194	2966
CHARLESTON	AFRICA/MIDDLE EAST	33744	36846	2748	3428	1628	1828	67867	99791	5679	8977	3310	5055
CHARLESTON	LATIN AMERICA	54216	107198	4357	8109	2636	5179	78404	115161	5602	8357	3642	5390
CHARLESTON	CANADA	142	2588	29	150	13	119	1503	10	75	1	68	0
CHARLESTON	TOTAL	1513149	1844864	144799	174908	82168	99932	2064963	2383613	143267	167871	95880	111429
SAVANNAH	EUROPE	469317	440367	40453	37011	24450	22741	626336	697171	46637	51908	29104	32626
SAVANNAH	EAST AND SOUTH ASIA	859736	576120	102473	70999	53977	36559	743609	671320	48929	44755	34335	31083
SAVANNAH	AUSTRALIA/OCEANIA	3154	568	222	41	146	26	6713	20336	471	1584	307	969
SAVANNAH	AFRICA/MIDDLE EAST	69569	50054	5788	4145	3560	2582	233746	268182	20418	21910	11715	13073
SAVANNAH	LATIN AMERICA	202401	106901	19407	9105	10931	5489	216025	133504	14313	9288	9989	6182
SAVANNAH	CANADA	633	85898	49	4300	31	3904	0	3280	0	168	0	149
SAVANNAH	TOTAL	1604810	1259908	168392	125601	93095	71301	1826429	1793793	130768	129613	85450	84082
JACKSONVILLE	EUROPE	50123	48084	3844	3279	2514	2308	132827	150877	10903	11981	6326	7144
JACKSONVILLE	EAST AND SOUTH ASIA	631	25025	56	4240	32	2121	370	17270	24	1303	16	785
JACKSONVILLE	AUSTRALIA/OCEANIA	0	647	0	72	0	34	33	22	2	1	1	0
JACKSONVILLE	AFRICA/MIDDLE EAST	9800	192	774	13	484	9	1945	1225	101	90	88	55
JACKSONVILLE	LATIN AMERICA	204961	313081	23153	33189	11894	17481	78533	152769	6482	11340	3679	7057
JACKSONVILLE	CANADA	113	24667	20	1240	9	1123	0	0	0	0	0	0
JACKSONVILLE	TOTAL	265628	411696	27847	42033	14933	23076	213708	322163	17512	24715	10110	15041

Source: Manalytics Waterborne Trade Database

U.S. LINER

U.S. PORT	FOREIGN REGION	1986 TONS
MIAMI	EUROPE	245972
MIAMI	EAST AND SOUTH ASIA	148766
MIAMI	AUSTRALIA/OCEANIA	504
MIAMI	AFRICA/MIDDLE EAST	14038
MIAMI	LATIN AMERICA	315033
MIAMI	CANADA	305
MIAMI	TOTAL	724618
OTHER SOUTH FLORIDA PORTS	EUROPE	281431
OTHER SOUTH FLORIDA PORTS	EAST AND SOUTH ASIA	1390
OTHER SOUTH FLORIDA PORTS	AUSTRALIA/OCEANIA	11010
OTHER SOUTH FLORIDA PORTS	AFRICA/MIDDLE EAST	8679
OTHER SOUTH FLORIDA PORTS	LATIN AMERICA	243226
OTHER SOUTH FLORIDA PORTS	CANADA	26
OTHER SOUTH FLORIDA PORTS	TOTAL	545762
PUERTO RICO/VIRGIN ISLANDS	EUROPE	201366
PUERTO RICO/VIRGIN ISLANDS	EAST AND SOUTH ASIA	45641
PUERTO RICO/VIRGIN ISLANDS	AUSTRALIA/OCEANIA	307
PUERTO RICO/VIRGIN ISLANDS	AFRICA/MIDDLE EAST	5450
PUERTO RICO/VIRGIN ISLANDS	LATIN AMERICA	199020
PUERTO RICO/VIRGIN ISLANDS	CANADA	14320
PUERTO RICO/VIRGIN ISLANDS	TOTAL	466104

Source: Manalytics Waterborne Trade Database

Appendix Table 5

CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

IMPORTS					EXPORTS					
1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS	1986 TONS	1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS
275959	18403	19627	12395	13740	39743	30262	3157	2446	1836	1423
159618	18814	20260	9656	10409	40047	56123	2973	4162	1855	2602
306	49	46	27	22	90	893	6	72	3	41
12147	1206	1139	739	674	3848	3297	324	365	187	194
331758	29379	30042	16499	17276	284747	315484	26188	29187	14487	16176
766	19	50	13	34	210	0	11	0	9	0
780554	67870	71164	39329	42155	368685	406059	32659	36232	18377	20436
249111	21394	19379	13903	12434	32917	25934	2593	2836	1606	1557
1480	157	140	78	76	792	3629	57	301	35	165
11180	1021	1054	531	541	281	552	27	37	14	23
11085	663	771	409	510	869	649	66	53	38	30
272748	24470	27562	12857	14526	223342	322454	20396	29639	11337	16373
332	1	23	1	15	209	0	21	0	10	0
545936	47706	48329	27779	28102	258410	353218	23160	32866	13040	18148
181979	14286	12992	9811	8823	18879	31252	1574	2639	908	1491
56478	6451	7690	3223	3882	4205	15148	237	980	191	690
750	27	71	14	36	7	143	1	15	0	6
8721	443	512	266	402	3715	3328	276	226	173	155
220200	20294	20822	10960	11696	118727	91425	9439	7236	5685	4456
8949	1216	762	697	437	47	160	3	10	2	7
477077	42717	42849	24971	25276	145580	141456	11530	11106	6959	6805

Appendix Table 5

U.S. LINER CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

		IMPORTS						EXPORTS					
		1986	1987	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987
U.S. PORT	FOREIGN REGION	TONS	TONS	TEUS	TEUS	FEUS	FEUS	TONS	TONS	TEUS	TEUS	FEUS	FEUS
OTHER SOUTH ATLANTIC PORTS	EUROPE	2650	12287	321	1044	154	628	3172	34256	257	2146	148	1586
OTHER SOUTH ATLANTIC PORTS	EAST AND SOUTH ASIA	59	10533	8	1223	3	658	8980	13045	700	917	407	593
OTHER SOUTH ATLANTIC PORTS	AUSTRALIA/OCEANIA	13	29	1	2	0	1	16	0	0	0	0	0
OTHER SOUTH ATLANTIC PORTS	AFRICA/MIDDLE EAST	8	371	2	47	0	22	15308	12827	1493	1035	732	591
OTHER SOUTH ATLANTIC PORTS	LATIN AMERICA	1163	1546	59	98	52	74	2604	25141	218	2135	124	1255
OTHER SOUTH ATLANTIC PORTS	TOTAL	3899	24766	391	2414	209	1383	30080	85269	2668	6233	1411	4025
TAMPA/ST. PETERSBURG	EUROPE	93	15853	6	1128	4	754	86	9269	4	590	3	439
TAMPA/ST. PETERSBURG	EAST AND SOUTH ASIA	116	860	7	83	5	43	1583	2027	110	135	72	92
TAMPA/ST. PETERSBURG	AUSTRALIA/OCEANIA	287	71	23	6	13	3	0	3	0	0	0	0
TAMPA/ST. PETERSBURG	AFRICA/MIDDLE EAST	26	1559	2	121	1	71	1479	212	112	16	69	9
TAMPA/ST. PETERSBURG	LATIN AMERICA	12572	17812	1266	1355	663	880	15177	23102	1149	1738	710	1087
TAMPA/ST. PETERSBURG	CANADA	0	60	0	3	0	2	2	0	0	0	0	0
TAMPA/ST. PETERSBURG	TOTAL	13094	36215	1304	2696	686	1753	18327	34613	1375	2479	854	1627
MOBILE	EUROPE	47196	37720	3232	2875	2236	1826	86736	109791	6012	8375	3974	5031
MOBILE	EAST AND SOUTH ASIA	3486	9228	293	809	171	441	175	3219	11	267	7	146
MOBILE	AUSTRALIA/OCEANIA	895	5	81	0	42	0	45	666	3	50	1	30
MOBILE	AFRICA/MIDDLE EAST	999	1040	81	80	47	51	8576	10492	562	788	388	483
MOBILE	LATIN AMERICA	6218	12197	583	961	334	563	22246	7705	1660	498	1029	349
MOBILE	CANADA	69	0	8	0	3	0	91	0	6	0	3	0
MOBILE	TOTAL	58863	60190	4278	4725	2833	2881	117869	131873	8254	9978	5402	6039

Source: Manalytics Waterborne Trade Database

U.S. LINER

U.S. PORT	FOREIGN REGION	1986 TONS
OTHER CENTRAL GULF PORTS	EUROPE	43611
OTHER CENTRAL GULF PORTS	EAST AND SOUTH ASIA	4802
OTHER CENTRAL GULF PORTS	AUSTRALIA/OCEANIA	4170
OTHER CENTRAL GULF PORTS	AFRICA/MIDDLE EAST	10720
OTHER CENTRAL GULF PORTS	LATIN AMERICA	308530
OTHER CENTRAL GULF PORTS	CANADA	77
OTHER CENTRAL GULF PORTS	TOTAL	371910
NEW ORLEANS	EUROPE	368760
NEW ORLEANS	EAST AND SOUTH ASIA	62395
NEW ORLEANS	AUSTRALIA/OCEANIA	21638
NEW ORLEANS	AFRICA/MIDDLE EAST	54635
NEW ORLEANS	LATIN AMERICA	236594
NEW ORLEANS	CANADA	62
NEW ORLEANS	TOTAL	744084
MISSISSIPPI RIVER SYSTEM PORTS	EUROPE	2551
MISSISSIPPI RIVER SYSTEM PORTS	EAST AND SOUTH ASIA	380
MISSISSIPPI RIVER SYSTEM PORTS	AUSTRALIA/OCEANIA	0
MISSISSIPPI RIVER SYSTEM PORTS	AFRICA/MIDDLE EAST	2183
MISSISSIPPI RIVER SYSTEM PORTS	LATIN AMERICA	201
MISSISSIPPI RIVER SYSTEM PORTS	TOTAL	5315

Source: Manalytics Waterborne Trade Database

Appendix Table 5

CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

IMPORTS					EXPORTS					
1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS	1986 TONS	1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS
38653	3296	2953	2127	1895	61949	139950	4129	10039	2839	6379
2961	319	172	236	138	10905	3690	772	256	495	167
8062	387	743	205	387	148	254	12	13	7	11
6969	700	460	487	316	46762	26015	2680	1619	2133	1188
401781	46870	61171	21263	27659	17080	48359	1246	3668	808	2244
0	3	0	3	0	0	4	0	0	0	0
458426	51575	65499	24321	30395	136844	218272	8839	15595	6282	9989
328898	29177	26611	18665	16657	721273	680346	52296	50172	33285	31428
20293	4319	1783	3036	1089	158087	237631	10391	16784	7207	10823
22476	1996	2021	1043	1091	22115	42251	1632	2827	1051	1976
42847	3738	3172	2579	2037	191936	214408	12547	14722	8830	9877
321114	23919	29046	12880	16680	474527	443727	32425	30909	21934	20507
35	9	2	4	1	137	232	8	23	5	11
735663	63158	62635	38209	37555	1568075	1618595	109299	115437	72312	74622
1967	191	116	127	91	45722	131642	3329	8496	2078	5983
99	37	8	20	4	3908	27450	326	1845	177	1246
399	0	40	0	19	344	3531	17	243	15	160
399	109	46	99	23	31436	34530	1825	1963	1429	1568
3255	35	163	16	148	32758	14563	2196	1005	1487	662
6119	372	373	262	285	114168	211716	7693	13552	5186	9619

U.S. LINER

U.S. PORT	FOREIGN REGION	1986 TONS
LAKE CHARLES/BEAUMONT/PORT ARTHUR	EUROPE	65
LAKE CHARLES/BEAUMONT/PORT ARTHUR	EAST AND SOUTH ASIA	164
LAKE CHARLES/BEAUMONT/PORT ARTHUR	AFRICA/MIDDLE EAST	542
LAKE CHARLES/BEAUMONT/PORT ARTHUR	LATIN AMERICA	3289
LAKE CHARLES/BEAUMONT/PORT ARTHUR	CANADA	0
LAKE CHARLES/BEAUMONT/PORT ARTHUR	TOTAL	4060
HOUSTON/GALVESTON	EUROPE	868631
HOUSTON/GALVESTON	EAST AND SOUTH ASIA	99402
HOUSTON/GALVESTON	AUSTRALIA/OCEANIA	10661
HOUSTON/GALVESTON	AFRICA/MIDDLE EAST	105552
HOUSTON/GALVESTON	LATIN AMERICA	98188
HOUSTON/GALVESTON	CANADA	872
HOUSTON/GALVESTON	TOTAL	1183306
CORPUS CHRISTI	EUROPE	23
CORPUS CHRISTI	EAST AND SOUTH ASIA	0
CORPUS CHRISTI	AFRICA/MIDDLE EAST	49
CORPUS CHRISTI	LATIN AMERICA	0
CORPUS CHRISTI	TOTAL	72

Source: Manalytics Waterborne Trade Database

Appendix Table 5

R CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

IMPORTS					EXPORTS					
1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS	1986 TONS	1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS
275	7	23	3	13	7494	31747	541	2087	340	1442
625	21	91	10	42	7154	48532	538	3289	325	2205
36	89	3	43	1	107197	88978	6995	6261	4874	4044
18064	332	1837	166	932	42136	154993	2747	10658	1933	7138
313	0	19	0	14	0	0	0	0	0	0
19313	449	1973	222	1002	163981	324250	10821	22295	7472	14829
793832	69891	65039	44271	40883	847965	1115364	61402	82450	39421	51919
100906	8007	9205	5113	5631	653120	632254	45064	43710	29745	28960
12032	921	1095	512	583	62425	84020	4289	5565	2866	3848
54652	7615	4414	5089	2828	366504	445752	27421	31726	17083	20818
174041	8038	14012	4935	8646	476003	535709	31013	35391	21776	24533
2716	82	137	49	123	214	21	15	1	9	0
1138179	94554	93902	59969	58694	2406231	2813120	169204	198843	110900	130078
0	1	0	1	0	2063	8	161	0	93	0
0	0	0	0	0	0	3497	0	262	0	158
2049	6	150	3	92	19198	18107	1237	1182	872	822
0	0	0	0	0	4289	13217	260	847	194	600
2049	7	150	4	92	25550	34829	1658	2291	1159	1580

U.S. LINER

U.S. PORT	FOREIGN REGION	1986 TONS
OTHER WEST GULF PORTS	EUROPE	126
OTHER WEST GULF PORTS	EAST AND SOUTH ASIA	10171
OTHER WEST GULF PORTS	AFRICA/MIDDLE EAST	0
OTHER WEST GULF PORTS	LATIN AMERICA	202070
OTHER WEST GULF PORTS	TOTAL	212367
LAKE MICHIGAN PORTS	EUROPE	8710
LAKE MICHIGAN PORTS	EAST AND SOUTH ASIA	3580
LAKE MICHIGAN PORTS	AUSTRALIA/OCEANIA	0
LAKE MICHIGAN PORTS	AFRICA/MIDDLE EAST	76
LAKE MICHIGAN PORTS	LATIN AMERICA	456
LAKE MICHIGAN PORTS	CANADA	909
LAKE MICHIGAN PORTS	TOTAL	13731
LAKE ERIE PORTS	EUROPE	20140
LAKE ERIE PORTS	EAST AND SOUTH ASIA	586
LAKE ERIE PORTS	AUSTRALIA/OCEANIA	135
LAKE ERIE PORTS	AFRICA/MIDDLE EAST	1236
LAKE ERIE PORTS	LATIN AMERICA	2
LAKE ERIE PORTS	CANADA	1
LAKE ERIE PORTS	TOTAL	22100

Source: Manalytics Waterborne Trade Database

Appendix Table 5

CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

IMPORTS					EXPORTS					
1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS	1986 TONS	1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS
67	8	3	5	2	0	0	0	0	0	0
637	508	50	462	33	0	206	0	15	0	9
0	0	0	0	0	3017	14608	221	1070	137	663
178585	31419	27817	14146	12520	13817	9098	1041	647	658	418
179289	31935	27870	14613	12555	16834	23912	1262	1732	795	1090
10976	601	638	413	504	3521	1115	192	72	159	50
2736	249	228	178	144	26140	6621	1805	422	1187	300
0	0	0	0	0	26	68	2	5	1	3
232	5	30	3	13	63416	43589	3870	2979	2897	1995
10	36	2	21	1	14165	274	919	13	664	12
35	46	2	41	1	0	0	0	0	0	0
13989	937	900	656	663	107268	51667	6788	3491	4908	2360
16183	1551	1176	1009	785	1670	1691	151	149	90	82
685	78	66	37	35	1062	6	53	0	48	0
1594	13	79	6	72	0	0	0	0	0	0
1195	66	97	55	60	1002	31	80	1	44	1
22	0	1	0	0	64	25	4	3	2	1
918	0	46	0	41	3	13	0	1	0	0
20597	1708	1465	1107	993	3801	1766	288	154	184	84

U.S. LINE

U.S. PORT	FOREIGN REGION	1986 TONS
OTHER GREAT LAKES PORTS	EUROPE	607
OTHER GREAT LAKES PORTS	EAST AND SOUTH ASIA	10
OTHER GREAT LAKES PORTS	AUSTRALIA/OCEANIA	0
OTHER GREAT LAKES PORTS	AFRICA/MIDDLE EAST	0
OTHER GREAT LAKES PORTS	LATIN AMERICA	1369
OTHER GREAT LAKES PORTS	CANADA	113
OTHER GREAT LAKES PORTS	TOTAL	2099
LONG BEACH/LOS ANGELES	EUROPE	798083
LONG BEACH/LOS ANGELES	EAST AND SOUTH ASIA	7656621
LONG BEACH/LOS ANGELES	AUSTRALIA/OCEANIA	202915
LONG BEACH/LOS ANGELES	AFRICA/MIDDLE EAST	65914
LONG BEACH/LOS ANGELES	LATIN AMERICA	99241
LONG BEACH/LOS ANGELES	CANADA	15387
LONG BEACH/LOS ANGELES	TOTAL	8838161
OTHER SOUTHERN CALIFORNIA PORTS	EUROPE	66650
OTHER SOUTHERN CALIFORNIA PORTS	EAST AND SOUTH ASIA	816
OTHER SOUTHERN CALIFORNIA PORTS	AFRICA/MIDDLE EAST	0
OTHER SOUTHERN CALIFORNIA PORTS	LATIN AMERICA	598
OTHER SOUTHERN CALIFORNIA PORTS	CANADA	691
OTHER SOUTHERN CALIFORNIA PORTS	TOTAL	68755

Source: Manalytics Waterborne Trade Database

Appendix Table 5

R CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

---------- I M P O R T S	-------------------				------------------- E X P O R T S	-------------------				
1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS	1986 TONS	1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS
580	46	33	28	26	185	137	14	7	8	5
0	1	0	0	0	39718	5304	2520	377	1805	241
0	0	0	0	0	0	2	0	0	0	0
0	0	0	0	0	11229	120	712	9	510	5
0	134	0	62	0	399	0	27	0	18	0
164	11	15	5	8	5831	2126	336	168	265	97
744	192	48	95	34	57362	7689	3609	561	2606	348
919472	67682	72524	41843	46959	232943	288987	19191	24289	11411	14385
8203997	1130645	1195085	556738	591099	4299805	5406536	330034	413082	201057	253976
255662	18164	22335	10012	12481	239187	262318	18921	21113	11515	12724
134330	5087	8635	3371	6531	69190	82105	5651	6700	3290	4008
151636	8617	11749	5141	7395	49896	41139	3493	3225	2335	1977
11389	1178	747	750	527	1544	1220	113	87	72	56
9676486	1231373	1311075	617855	664992	4892565	6082305	377403	468496	229680	287126
85585	3424	4691	3029	3920	0	0	0	0	0	0
497	173	68	80	35	1551	4467	156	442	75	218
3233	0	222	0	146	0	19	0	1	0	0
5225	56	303	29	240	0	0	0	0	0	0
0	34	0	31	0	0	0	0	0	0	0
94540	3687	5284	3169	4341	1551	4486	156	443	75	218

U.S. LINER

U.S. PORT	FOREIGN REGION	1986 TONS
OAKLAND/SAN FRANCISCO	EUROPE	342974
OAKLAND/SAN FRANCISCO	EAST AND SOUTH ASIA	1385326
OAKLAND/SAN FRANCISCO	AUSTRALIA/OCEANIA	208397
OAKLAND/SAN FRANCISCO	AFRICA/MIDDLE EAST	24888
OAKLAND/SAN FRANCISCO	LATIN AMERICA	100140
OAKLAND/SAN FRANCISCO	CANADA	6373
OAKLAND/SAN FRANCISCO	TOTAL	2068098
OTHER SAN FRANCISCO BAY/SACRAMENTO	EUROPE	677
OTHER SAN FRANCISCO BAY/SACRAMENTO	EAST AND SOUTH ASIA	53
OTHER SAN FRANCISCO BAY/SACRAMENTO	AUSTRALIA/OCEANIA	1098
OTHER SAN FRANCISCO BAY/SACRAMENTO	AFRICA/MIDDLE EAST	1781
OTHER SAN FRANCISCO BAY/SACRAMENTO	LATIN AMERICA	73
OTHER SAN FRANCISCO BAY/SACRAMENTO	TOTAL	3682
OTHER NORTHERN CALIFORNIA PORTS	EUROPE	2832
OTHER NORTHERN CALIFORNIA PORTS	EAST AND SOUTH ASIA	609
OTHER NORTHERN CALIFORNIA PORTS	LATIN AMERICA	0
OTHER NORTHERN CALIFORNIA PORTS	TOTAL	3441

Source: Manalytics Waterborne Trade Database

Appendix Table 5

R CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

IMPORTS					EXPORTS					
1987	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987
TONS	TEUS	TEUS	FEUS	FEUS	TONS	TONS	TEUS	TEUS	FEUS	FEUS
372572	30287	32921	18083	19592	306162	358194	24740	29949	14444	16972
1272830	179820	162460	91348	83512	2238746	2763148	170943	211010	105043	129218
219180	18943	19750	10175	10622	141455	139413	11290	10713	6680	6558
23372	1626	1710	1161	1100	26733	36379	2170	3097	1281	1772
155687	7518	11596	4689	7255	34432	33216	2454	2551	1606	1575
4067	574	295	334	189	2567	2332	168	164	116	106
2047708	238768	228732	125790	122270	2750095	3332682	211765	257484	129170	156201
15177	74	955	40	702	1452	5848	114	342	67	266
681	9	104	3	48	17889	6210	1227	405	812	281
38	67	3	49	1	82	7020	16	500	7	318
10	89	0	80	0	26	501	2	38	1	22
1016	5	72	3	46	20	1607	2	115	0	72
16922	244	1134	175	797	19469	21186	1361	1400	887	959
581	252	59	148	31	5409	2066	383	160	245	93
281	39	29	28	14	6032	10332	415	711	274	469
19	0	1	0	0	0	0	0	0	0	0
881	291	89	176	45	11441	12398	798	871	519	562

U.S. LINER

U.S. PORT	FOREIGN REGION	1986 TONS
HONOLULU/HAWAII PORTS	EUROPE	1658
HONOLULU/HAWAII PORTS	EAST AND SOUTH ASIA	53591
HONOLULU/HAWAII PORTS	AUSTRALIA/OCEANIA	36346
HONOLULU/HAWAII PORTS	AFRICA/MIDDLE EAST	132
HONOLULU/HAWAII PORTS	LATIN AMERICA	125
HONOLULU/HAWAII PORTS	CANADA	533
HONOLULU/HAWAII PORTS	TOTAL	92385
PORTLAND, OR	EUROPE	24396
PORTLAND, OR	EAST AND SOUTH ASIA	148610
PORTLAND, OR	AUSTRALIA/OCEANIA	1842
PORTLAND, OR	AFRICA/MIDDLE EAST	151
PORTLAND, OR	LATIN AMERICA	583
PORTLAND, OR	CANADA	16
PORTLAND, OR	TOTAL	175598
OTHER COLUMBIA RIVER PORTS	EUROPE	795
OTHER COLUMBIA RIVER PORTS	EAST AND SOUTH ASIA	4484
OTHER COLUMBIA RIVER PORTS	AUSTRALIA/OCEANIA	210
OTHER COLUMBIA RIVER PORTS	AFRICA/MIDDLE EAST	1590
OTHER COLUMBIA RIVER PORTS	LATIN AMERICA	900
OTHER COLUMBIA RIVER PORTS	TOTAL	7979

Source: Manalytics Waterborne Trade Database

Appendix Table 5

CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

IMPORTS					EXPORTS					
1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS	1986 TONS	1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS
1816	136	236	83	122	2	325	0	23	0	14
60959	6471	7011	3372	3754	46436	46101	3425	3435	2148	2149
28568	2891	2389	1712	1371	2360	638	154	78	109	37
0	7	0	5	0	90	0	9	0	4	0
66	14	6	7	3	45	14	3	1	1	0
843	49	77	24	38	1832	1578	125	110	89	77
92252	9568	9719	5203	5288	50765	48656	3716	3647	2351	2277
29340	2065	2574	1230	1510	66884	76691	4488	5364	3109	3575
161474	16524	18579	8991	9975	880137	928188	65431	70055	40555	42917
2137	126	150	87	99	3754	3144	294	247	175	143
140	16	14	8	7	1977	2617	170	215	96	122
2906	42	208	26	134	2961	215	207	15	146	9
25140	1	1258	0	1142	0	0	0	0	0	0
221137	18774	22783	10342	12867	955713	1010855	70590	75896	44081	46766
12	71	1	40	0	14992	30466	886	1865	682	1384
4273	381	321	231	210	18700	27679	1396	2097	850	1260
1725	15	89	10	78	11401	12617	687	1007	519	582
300	96	16	73	13	5718	1692	429	128	260	77
2878	66	212	40	132	14837	15026	981	982	678	687
9188	629	639	394	433	65648	87480	4379	6079	2989	3990

U.S. LINER

U.S. PORT	FOREIGN REGION	1986 TONS
SEATTLE/TACOMA	EUROPE	127680
SEATTLE/TACOMA	EAST AND SOUTH ASIA	2965578
SEATTLE/TACOMA	AUSTRALIA/OCEANIA	49486
SEATTLE/TACOMA	AFRICA/MIDDLE EAST	13172
SEATTLE/TACOMA	LATIN AMERICA	24907
SEATTLE/TACOMA	CANADA	951
SEATTLE/TACOMA	TOTAL	3181774
OTHER PUGET SOUND PORTS	EUROPE	1397
OTHER PUGET SOUND PORTS	EAST AND SOUTH ASIA	2739
OTHER PUGET SOUND PORTS	AUSTRALIA/OCEANIA	0
OTHER PUGET SOUND PORTS	AFRICA/MIDDLE EAST	44
OTHER PUGET SOUND PORTS	LATIN AMERICA	543
OTHER PUGET SOUND PORTS	CANADA	2333
OTHER PUGET SOUND PORTS	TOTAL	7056
OTHER PACIFIC NORTHWEST PORTS	EUROPE	308
OTHER PACIFIC NORTHWEST PORTS	EAST AND SOUTH ASIA	2421
OTHER PACIFIC NORTHWEST PORTS	AUSTRALIA/OCEANIA	94
OTHER PACIFIC NORTHWEST PORTS	AFRICA/MIDDLE EAST	76
OTHER PACIFIC NORTHWEST PORTS	LATIN AMERICA	0
OTHER PACIFIC NORTHWEST PORTS	TOTAL	2899

Source: Manalytics Waterborne Trade Database

Appendix Table 5

R CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

IMPORTS					EXPORTS					
1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS	1986 TONS	1987 TONS	1986 TEUS	1987 TEUS	1986 FEUS	1987 FEUS
105962	11505	9711	6876	5716	168892	122643	14437	10419	7973	5862
3170045	428907	452943	213733	225613	3645172	4213129	275837	319282	169816	196376
79584	4787	6757	2608	3954	108263	147373	8580	11246	5116	6960
8063	968	809	669	469	21216	35432	1984	2436	1071	1689
23225	1971	1820	1235	1126	57984	46198	4071	3402	2667	2136
20950	56	1185	44	964	1791	2011	93	114	81	91
3407829	448194	473225	225165	237842	4003318	4566786	305002	346899	186724	213114
758	111	83	71	43	7574	9339	604	694	344	431
8852	321	809	176	507	23150	43723	1709	2706	1055	1988
0	0	0	0	0	977	670	76	46	44	30
2	3	0	1	0	0	0	0	0	0	0
112	37	7	24	5	3740	8325	257	573	169	378
3999	275	471	124	212	16071	12473	989	1104	751	605
13723	747	1370	396	767	51512	74530	3635	5123	2363	3432
459	25	43	16	25	6219	5997	506	459	285	272
475	145	33	115	22	0	724	0	53	0	32
451	8	37	4	21	21586	31678	1693	2491	980	1438
628	3	31	3	28	106	1872	8	146	4	84
0	0	0	0	0	2	5	0	0	0	0
2013	181	144	138	96	27913	40276	2207	3149	1269	1826

Appendix Table 5

U.S. LINER CONTAINER TRADES BY MAJOR PORT
(SHORT TONS)

		IMPORTS						EXPORTS					
		1986	1987	1986	1987	1986	1987	1986	1987	1986	1987	1986	1987
U.S. PORT	FOREIGN REGION	TONS	TONS	TEUS	TEUS	FEUS	FEUS	TONS	TONS	TEUS	TEUS	FEUS	FEUS
ALASKA PORTS	EUROPE	123	527	6	62	5	28	341	1658	31	126	17	77
ALASKA PORTS	EAST AND SOUTH ASIA	345	2	39	0	21	0	26999	22629	2985	2101	1386	1105
ALASKA PORTS	AUSTRALIA/OCEANIA	0	0	0	0	0	0	0	112	0	9	0	5
ALASKA PORTS	AFRICA/MIDDLE EAST	8	0	0	0	0	0	175	4385	18	435	8	200
ALASKA PORTS	LATIN AMERICA	0	0	0	0	0	0	1597	47	157	5	72	2
ALASKA PORTS	CANADA	499	1136	30	71	23	53	15	621	1	79	0	39
ALASKA PORTS	TOTAL	975	1665	75	133	49	81	29127	29452	3192	2755	1483	1428

Source: Manalytics Waterborne Trade Database

Appendix Table 6

TRAM DATA PRESUMED TO FIT RAIL NETWORK
BY BEA ORIGIN AND DESTINATION

ORIGIN BEA	DESTINATION BEA	SITING COUNT	FACTORED MONTHLY COUNT	FACTORED ANNUAL COUNT
4 BOSTON, MA	165 SALT LAKE CITY-OGDEN, UT	1	1,029	12,348
4 BOSTON, MA	172 PORTLAND, OR	1	345	4,140
4 BOSTON, MA	176 SAN FRANCISCO-OAKLAND-SAN JOSE	1	674	8,088
4 BOSTON, MA	....	3	2,048	24,576
6 HARTFORD-NEW HAVEN-SPRINGFLD,	164 RENO, NV	1	1,029	12,348
6 HARTFORD-NEW HAVEN-SPRINGFLD,	165 SALT LAKE CITY-OGDEN, UT	1	674	8,088
6 HARTFORD-NEW HAVEN-SPRINGFLD,	....	2	1,703	20,436
7 ALBANY-SCHENECTADY-TROY, NY	162 PHOENIX, AZ	1	641	7,692
7 ALBANY-SCHENECTADY-TROY, NY	178 STOCKTON-MODESTO, CA	1	1,029	12,348
7 ALBANY-SCHENECTADY-TROY, NY	....	2	1,670	20,040
8 SYRACUSE-UTICA, NY	172 PORTLAND, OR	1	674	8,088
8 SYRACUSE-UTICA, NY	176 SAN FRANCISCO-OAKLAND-SAN JOSE	1	1,029	12,348
8 SYRACUSE-UTICA, NY	....	2	1,703	20,436
9 ROCHESTER, NY	176 SAN FRANCISCO-OAKLAND-SAN JOSE	1	641	7,692
9 ROCHESTER, NY	180 LOS ANGELES, CA	4	2,537	30,444
9 ROCHESTER, NY	....	5	3,178	38,136
10 BUFFALO, NY	177 SACRAMENTO, CA	1	674	8,088
10 BUFFALO, NY	178 STOCKTON-MODESTO, CA	1	1,029	12,348
10 BUFFALO, NY	180 LOS ANGELES, CA	1	641	7,692
10 BUFFALO, NY	....	3	2,344	28,128
12 NEW YORK, NY	162 PHOENIX, AZ	1	614	7,368
12 NEW YORK, NY	164 RENO, NV	1	1,029	12,348
12 NEW YORK, NY	171 SEATTLE, WA	1	674	8,088
12 NEW YORK, NY	172 PORTLAND, OR	1	1,029	12,348
12 NEW YORK, NY	176 SAN FRANCISCO-OAKLAND-SAN JOSE	6	4,306	51,672
12 NEW YORK, NY	180 LOS ANGELES, CA	5	2,893	34,716
12 NEW YORK, NY	....	15	10,545	126,540
15 ERIE, PA	162 PHOENIX, AZ	1	641	7,692

Appendix Table 6

TRAM DATA PRESUMED TO FIT RAIL NETWORK
BY BEA ORIGIN AND DESTINATION

ORIGIN BEA	DESTINATION BEA	SITING COUNT	FACTORED MONTHLY COUNT	FACTORED ANNUAL COUNT
15 ERIE, PA	....	1	641	7,692
16 PITTSBURGH, PA	165 SALT LAKE CITY-OGDEN, UT	1	674	8,088
16 PITTSBURGH, PA	....	1	674	8,088
17 HARRISBURG-YORK-LANCASTER, PA	172 PORTLAND, OR	1	674	8,088
17 HARRISBURG-YORK-LANCASTER, PA	....	1	674	8,088
18 PHILADELPHIA, PA	172 PORTLAND, OR	1	674	8,088
18 PHILADELPHIA, PA	176 SAN FRANCISCO-OAKLAND-SAN JOSE	2	1,282	15,384
18 PHILADELPHIA, PA	180 LOS ANGELES, CA	7	4,460	53,520
18 PHILADELPHIA, PA	....	10	6,416	76,992
19 BALTIMORE, MD	180 LOS ANGELES, CA	2	1,282	15,384
19 BALTIMORE, MD	....	2	1,282	15,384
20 WASHINGTON, DC	169 RICHLAND, WA	1	1,029	12,348
20 WASHINGTON, DC	....	1	1,029	12,348
55 MEMPHIS, TN	162 PHOENIX, AZ	2	1,444	17,328
55 MEMPHIS, TN	177 SACRAMENTO, CA	1	614	7,368
55 MEMPHIS, TN	178 STOCKTON-MODESTO, CA	1	614	7,368
55 MEMPHIS, TN	179 FRESNO-BAKERSFIELD, CA	1	722	8,664
55 MEMPHIS, TN	180 LOS ANGELES, CA	2	1,024	12,288
55 MEMPHIS, TN	....	7	4,418	53,016
65 CLEVELAND, OH	176 SAN FRANCISCO-OAKLAND-SAN JOSE	2	1,315	15,780
65 CLEVELAND, OH	180 LOS ANGELES, CA	2	1,336	16,032
65 CLEVELAND, OH	....	4	2,651	31,812
70 TOLEDO, OH	172 PORTLAND, OR	1	1,029	12,348
70 TOLEDO, OH	180 LOS ANGELES, CA	2	1,363	16,356
70 TOLEDO, OH	....	3	2,392	28,704
71 DETROIT, MI	180 LOS ANGELES, CA	4	2,958	35,496

Appendix Table 6

TRAM DATA PRESUMED TO FIT RAIL NETWORK
BY BEA ORIGIN AND DESTINATION

ORIGIN BEA	DESTINATION BEA	SITING COUNT	FACTORED MONTHLY COUNT	FACTORED ANNUAL COUNT
71 DETROIT, MI	....	4	2,958	35,496
76 FORT WAYNE, IN	164 RENO, NV	1	674	8,088
76 FORT WAYNE, IN	....	1	674	8,088
83 CHICAGO, IL	162 PHOENIX, AZ	2	1,051	12,612
83 CHICAGO, IL	164 RENO, NV	3	2,377	28,524
83 CHICAGO, IL	165 SALT LAKE CITY-OGDEN, UT	1	674	8,088
83 CHICAGO, IL	172 PORTLAND, OR	2	2,058	24,696
83 CHICAGO, IL	176 SAN FRANCISCO-OAKLAND-SAN JOSE	6	5,109	61,308
83 CHICAGO, IL	180 LOS ANGELES, CA	5	3,696	44,352
83 CHICAGO, IL	....	19	14,965	179,580
85 SPRINGFIELD-DECATUR, IL	180 LOS ANGELES, CA	1	722	8,664
85 SPRINGFIELD-DECATUR, IL	....	1	722	8,664
88 ROCKFORD, IL	180 LOS ANGELES, CA	1	674	8,088
88 ROCKFORD, IL	....	1	674	8,088
92 EAU CLAIRE, WI	162 PHOENIX, AZ	1	614	7,368
92 EAU CLAIRE, WI	165 SALT LAKE CITY-OGDEN, UT	1	1,029	12,348
92 EAU CLAIRE, WI	....	2	1,643	19,716
96 MINNEAPOLIS-ST. PAUL, MN	162 PHOENIX, AZ	1	614	7,368
96 MINNEAPOLIS-ST. PAUL, MN	165 SALT LAKE CITY-OGDEN, UT	1	1,029	12,348
96 MINNEAPOLIS-ST. PAUL, MN	180 LOS ANGELES, CA	1	614	7,368
96 MINNEAPOLIS-ST. PAUL, MN	....	3	2,257	27,084
99 DAVENPORT-ROCK ISLAND-MOLINE,	164 RENO, NV	1	1,029	12,348
99 DAVENPORT-ROCK ISLAND-MOLINE,	176 SAN FRANCISCO-OAKLAND-SAN JOSE	1	1,029	12,348
99 DAVENPORT-ROCK ISLAND-MOLINE,	180 LOS ANGELES, CA	1	1,029	12,348
99 DAVENPORT-ROCK ISLAND-MOLINE,	....	3	3,087	37,044
100 CEDAR RAPIDS, IA	179 FRESNO-BAKERSFIELD, CA	1	1,029	12,348
100 CEDAR RAPIDS, IA	....	1	1,029	12,348

Appendix Table 6

TRAM DATA PRESUMED TO FIT RAIL NETWORK
BY BEA ORIGIN AND DESTINATION

ORIGIN BEA	DESTINATION BEA	SITING COUNT	FACTORED MONTHLY COUNT	FACTORED ANNUAL COUNT
104 DES MOINES, IA	165 SALT LAKE CITY-OGDEN, UT	1	1,029	12,348
104 DES MOINES, IA	173 EUGENE, OR	1	1,029	12,348
104 DES MOINES, IA	174 REDDING, CA	1	345	4,140
104 DES MOINES, IA	180 LOS ANGELES, CA	3	1,869	22,428
104 DES MOINES, IA	....	6	4,272	51,264
105 KANSAS CITY, MO	165 SALT LAKE CITY-OGDEN, UT	3	2,732	32,784
105 KANSAS CITY, MO	171 SEATTLE, WA	1	674	8,088
105 KANSAS CITY, MO	176 SAN FRANCISCO-OAKLAND-SAN JOSE	1	641	7,692
105 KANSAS CITY, MO	....	5	4,047	48,564
107 ST. LOUIS, MO	162 PHOENIX, AZ	1	1,029	12,348
107 ST. LOUIS, MO	165 SALT LAKE CITY-OGDEN, UT	1	1,029	12,348
107 ST. LOUIS, MO	172 PORTLAND, OR	2	1,703	20,436
107 ST. LOUIS, MO	176 SAN FRANCISCO-OAKLAND-SAN JOSE	1	674	8,088
107 ST. LOUIS, MO	180 LOS ANGELES, CA	1	722	8,664
107 ST. LOUIS, MO	....	6	5,157	61,884
111 LITTLE ROCK-N. LITTLE ROCK, AR	162 PHOENIX, AZ	2	1,132	13,584
111 LITTLE ROCK-N. LITTLE ROCK, AR	177 SACRAMENTO, CA	1	614	7,368
111 LITTLE ROCK-N. LITTLE ROCK, AR	180 LOS ANGELES, CA	1	410	4,920
111 LITTLE ROCK-N. LITTLE ROCK, AR	....	4	2,156	25,872
113 NEW ORLEANS, LA	172 PORTLAND, OR	1	722	8,664
113 NEW ORLEANS, LA	180 LOS ANGELES, CA	2	820	9,840
113 NEW ORLEANS, LA	....	3	1,542	18,504
119 TEXARKANA, TX	165 SALT LAKE CITY-OGDEN, UT	1	1,029	12,348
119 TEXARKANA, TX	....	1	1,029	12,348
121 BEAUMONT-PORT ARTHUR, TX	180 LOS ANGELES, CA	3	1,230	14,760
121 BEAUMONT-PORT ARTHUR, TX	....	3	1,230	14,760
122 HOUSTON, TX	162 PHOENIX, AZ	1	722	8,664

Appendix Table 6

TRAM DATA PRESUMED TO FIT RAIL NETWORK
BY BEA ORIGIN AND DESTINATION

ORIGIN BEA	DESTINATION BEA	SITING COUNT	FACTORED MONTHLY COUNT	FACTORED ANNUAL COUNT
122 HOUSTON, TX	180 LOS ANGELES, CA	1	722	8,664
122 HOUSTON, TX	....	2	1,444	17,328
125 DALLAS-FORT WORTH, TX	123 AUSTIN, TX	1	410	4,920
125 DALLAS-FORT WORTH, TX	156 CHEYENNE-CASPER, WY	1	674	8,088
125 DALLAS-FORT WORTH, TX	161 TUCSON, AZ	1	722	8,664
125 DALLAS-FORT WORTH, TX	162 PHOENIX, AZ	13	5,954	71,448
125 DALLAS-FORT WORTH, TX	164 RENO, NV	1	614	7,368
125 DALLAS-FORT WORTH, TX	165 SALT LAKE CITY-OGDEN, UT	2	1,643	19,716
125 DALLAS-FORT WORTH, TX	171 SEATTLE, WA	1	345	4,140
125 DALLAS-FORT WORTH, TX	176 SAN FRANCISCO-OAKLAND-SAN JOSE	5	2,974	35,688
125 DALLAS-FORT WORTH, TX	177 SACRAMENTO, CA	1	641	7,692
125 DALLAS-FORT WORTH, TX	178 STOCKTON-MODESTO, CA	2	959	11,508
125 DALLAS-FORT WORTH, TX	180 LOS ANGELES, CA	21	13,007	156,084
125 DALLAS-FORT WORTH, TX	....	49	27,943	335,316
132 ODESSA-MIDLAND, TX	180 LOS ANGELES, CA	1	722	8,664
132 ODESSA-MIDLAND, TX	....	1	722	8,664
133 EL PASO, TX	171 SEATTLE, WA	1	641	7,692
133 EL PASO, TX	172 PORTLAND, OR	1	641	7,692
133 EL PASO, TX	178 STOCKTON-MODESTO, CA	1	410	4,920
133 EL PASO, TX	....	3	1,692	20,304
135 AMARILLO, TX	162 PHOENIX, AZ	1	410	4,920
135 AMARILLO, TX	178 STOCKTON-MODESTO, CA	1	614	7,368
135 AMARILLO, TX	180 LOS ANGELES, CA	1	641	7,692
135 AMARILLO, TX	....	3	1,665	19,980
139 WICHITA, KS	162 PHOENIX, AZ	1	641	7,692
139 WICHITA, KS	171 SEATTLE, WA	1	1,029	12,348
139 WICHITA, KS	180 LOS ANGELES, CA	1	614	7,368
139 WICHITA, KS	....	3	2,284	27,408
143 OMAHA, NE	162 PHOENIX, AZ	2	1,363	16,356

Appendix Table 6

TRAM DATA PRESUMED TO FIT RAIL NETWORK
BY BEA ORIGIN AND DESTINATION

ORIGIN BEA	DESTINATION BEA	SITING COUNT	FACTORED MONTHLY COUNT	FACTORED ANNUAL COUNT
143 OMAHA, NE	171 SEATTLE, WA	1	674	8,088
143 OMAHA, NE	176 SAN FRANCISCO-OAKLAND-SAN JOSE	1	674	8,088
143 OMAHA, NE	180 LOS ANGELES, CA	2	1,288	15,456
143 OMAHA, NE	....	6	3,999	47,988
144 GRAND ISLAND, NE	172 PORTLAND, OR	1	674	8,088
144 GRAND ISLAND, NE	....	1	674	8,088
156 CHEYENNE-CASPER, WY	172 PORTLAND, OR	1	397	4,764
156 CHEYENNE-CASPER, WY	178 STOCKTON-MODESTO, CA	1	1,029	12,348
156 CHEYENNE-CASPER, WY	....	2	1,426	17,112
160 ALBUQUERQUE, NM	162 PHOENIX, AZ	2	1,228	14,736
160 ALBUQUERQUE, NM	180 LOS ANGELES, CA	1	614	7,368
160 ALBUQUERQUE, NM	....	3	1,842	22,104
161 TUCSON, AZ	180 LOS ANGELES, CA	1	410	4,920
161 TUCSON, AZ	....	1	410	4,920
162 PHOENIX, AZ	4 BOSTON, MA	1	614	7,368
162 PHOENIX, AZ	12 NEW YORK, NY	1	410	4,920
162 PHOENIX, AZ	55 MEMPHIS, TN	1	722	8,664
162 PHOENIX, AZ	71 DETROIT, MI	3	1,692	20,304
162 PHOENIX, AZ	83 CHICAGO, IL	1	410	4,920
162 PHOENIX, AZ	122 HOUSTON, TX	1	410	4,920
162 PHOENIX, AZ	125 DALLAS-FORT WORTH, TX	5	2,986	35,832
162 PHOENIX, AZ	160 ALBUQUERQUE, NM	2	1,228	14,736
162 PHOENIX, AZ	161 TUCSON, AZ	1	722	8,664
162 PHOENIX, AZ	162 PHOENIX, AZ	1	410	4,920
162 PHOENIX, AZ	....	17	9,604	115,248
164 RENO, NV	168 SPOKANE, WA	1	397	4,764
164 RENO, NV	....	1	397	4,764
165 SALT LAKE CITY-OGDEN, UT	10 BUFFALO, NY	1	1,029	12,348

Appendix Table 6

TRAM DATA PRESUMED TO FIT RAIL NETWORK
BY BEA ORIGIN AND DESTINATION

ORIGIN BEA	DESTINATION BEA	SITING COUNT	FACTORED MONTHLY COUNT	FACTORED ANNUAL COUNT
165 SALT LAKE CITY-OGDEN, UT	55 MEMPHIS, TN	1	1,029	12,348
165 SALT LAKE CITY-OGDEN, UT	125 DALLAS-FORT WORTH, TX	2	1,228	14,736
165 SALT LAKE CITY-OGDEN, UT	145 SCOTTSBLUFF, NE	1	1,029	12,348
165 SALT LAKE CITY-OGDEN, UT	156 CHEYENNE-CASPER, WY	2	2,058	24,696
165 SALT LAKE CITY-OGDEN, UT	174 REDDING, CA	2	690	8,280
165 SALT LAKE CITY-OGDEN, UT	....	9	7,063	84,756
168 SPOKANE, WA	176 SAN FRANCISCO-OAKLAND-SAN JOSE	3	1,035	12,420
168 SPOKANE, WA	180 LOS ANGELES, CA	2	742	8,904
168 SPOKANE, WA	....	5	1,777	21,324
169 RICHLAND, WA	133 EL PASO, TX	1	397	4,764
169 RICHLAND, WA	176 SAN FRANCISCO-OAKLAND-SAN JOSE	2	794	9,528
169 RICHLAND, WA	177 SACRAMENTO, CA	1	397	4,764
169 RICHLAND, WA	178 STOCKTON-MODESTO, CA	1	345	4,140
169 RICHLAND, WA	180 LOS ANGELES, CA	1	345	4,140
169 RICHLAND, WA	....	6	2,278	27,336
170 YAKIMA, WA	18 PHILADELPHIA, PA	1	674	8,088
170 YAKIMA, WA	20 WASHINGTON, DC	1	674	8,088
170 YAKIMA, WA	122 HOUSTON, TX	2	1,315	15,780
170 YAKIMA, WA	141 TOPEKA, KS	1	1,029	12,348
170 YAKIMA, WA	176 SAN FRANCISCO-OAKLAND-SAN JOSE	2	742	8,904
170 YAKIMA, WA	177 SACRAMENTO, CA	1	397	4,764
170 YAKIMA, WA	178 STOCKTON-MODESTO, CA	1	345	4,140
170 YAKIMA, WA	179 FRESNO-BAKERSFIELD, CA	1	397	4,764
170 YAKIMA, WA	180 LOS ANGELES, CA	2	742	8,904
170 YAKIMA, WA	....	12	6,315	75,780
171 SEATTLE, WA	4 BOSTON, MA	1	674	8,088
171 SEATTLE, WA	65 CLEVELAND, OH	2	2,058	24,696
171 SEATTLE, WA	125 DALLAS-FORT WORTH, TX	1	1,029	12,348
171 SEATTLE, WA	160 ALBUQUERQUE, NM	1	614	7,368
171 SEATTLE, WA	162 PHOENIX, AZ	1	345	4,140
171 SEATTLE, WA	176 SAN FRANCISCO-OAKLAND-SAN JOSE	9	3,261	39,132

Appendix Table 6

TRAM DATA PRESUMED TO FIT RAIL NETWORK
BY BEA ORIGIN AND DESTINATION

ORIGIN BEA	DESTINATION BEA	SITING COUNT	FACTORED MONTHLY COUNT	FACTORED ANNUAL COUNT
171 SEATTLE, WA	177 SACRAMENTO, CA	3	1,035	12,420
171 SEATTLE, WA	178 STOCKTON-MODESTO, CA	2	794	9,528
171 SEATTLE, WA	180 LOS ANGELES, CA	13	4,745	56,940
171 SEATTLE, WA	....	33	14,555	174,660
172 PORTLAND, OR	12 NEW YORK, NY	2	2,058	24,696
172 PORTLAND, OR	83 CHICAGO, IL	1	1,029	12,348
172 PORTLAND, OR	125 DALLAS-FORT WORTH, TX	1	1,029	12,348
172 PORTLAND, OR	143 OMAHA, NE	1	1,029	12,348
172 PORTLAND, OR	162 PHOENIX, AZ	2	742	8,904
172 PORTLAND, OR	165 SALT LAKE CITY-OGDEN, UT	1	1,029	12,348
172 PORTLAND, OR	174 REDDING, CA	1	345	4,140
172 PORTLAND, OR	176 SAN FRANCISCO-OAKLAND-SAN JOSE	2	742	8,904
172 PORTLAND, OR	177 SACRAMENTO, CA	7	2,415	28,980
172 PORTLAND, OR	178 STOCKTON-MODESTO, CA	3	1,087	13,044
172 PORTLAND, OR	179 FRESNO-BAKERSFIELD, CA	1	345	4,140
172 PORTLAND, OR	180 LOS ANGELES, CA	14	5,263	63,156
172 PORTLAND, OR	....	36	17,113	205,356
173 EUGENE, OR	177 SACRAMENTO, CA	1	345	4,140
173 EUGENE, OR	180 LOS ANGELES, CA	1	345	4,140
173 EUGENE, OR	....	2	690	8,280
174 REDDING, CA	171 SEATTLE, WA	2	690	8,280
174 REDDING, CA	176 SAN FRANCISCO-OAKLAND-SAN JOSE	2	690	8,280
174 REDDING, CA	....	4	1,380	16,560
176 SAN FRANCISCO-OAKLAND-SAN JOSE	12 NEW YORK, NY	1	1,029	12,348
176 SAN FRANCISCO-OAKLAND-SAN JOSE	18 PHILADELPHIA, PA	1	410	4,920
176 SAN FRANCISCO-OAKLAND-SAN JOSE	96 MINNEAPOLIS-ST. PAUL, MN	1	674	8,088
176 SAN FRANCISCO-OAKLAND-SAN JOSE	105 KANSAS CITY, MO	2	2,058	24,696
176 SAN FRANCISCO-OAKLAND-SAN JOSE	113 NEW ORLEANS, LA	1	641	7,692
176 SAN FRANCISCO-OAKLAND-SAN JOSE	122 HOUSTON, TX	1	410	4,920
176 SAN FRANCISCO-OAKLAND-SAN JOSE	125 DALLAS-FORT WORTH, TX	2	1,336	16,032
176 SAN FRANCISCO-OAKLAND-SAN JOSE	162 PHOENIX, AZ	1	410	4,920

Appendix Table 6

TRAM DATA PRESUMED TO FIT RAIL NETWORK
BY BEA ORIGIN AND DESTINATION

ORIGIN BEA	DESTINATION BEA	SITING COUNT	FACTORED MONTHLY COUNT	FACTORED ANNUAL COUNT
176 SAN FRANCISCO-OAKLAND-SAN JOSE	168 SPOKANE, WA	4	1,432	17,184
176 SAN FRANCISCO-OAKLAND-SAN JOSE	171 SEATTLE, WA	12	4,244	50,928
176 SAN FRANCISCO-OAKLAND-SAN JOSE	172 PORTLAND, OR	7	2,571	30,852
176 SAN FRANCISCO-OAKLAND-SAN JOSE	174 REDDING, CA	5	1,777	21,324
176 SAN FRANCISCO-OAKLAND-SAN JOSE	180 LOS ANGELES, CA	1	722	8,664
176 SAN FRANCISCO-OAKLAND-SAN JOSE	....	39	17,714	212,568
177 SACRAMENTO, CA	12 NEW YORK, NY	1	674	8,088
177 SACRAMENTO, CA	18 PHILADELPHIA, PA	1	1,029	12,348
177 SACRAMENTO, CA	71 DETROIT, MI	1	1,029	12,348
177 SACRAMENTO, CA	83 CHICAGO, IL	1	1,029	12,348
177 SACRAMENTO, CA	107 ST. LOUIS, MO	1	641	7,692
177 SACRAMENTO, CA	139 WICHITA, KS	2	2,058	24,696
177 SACRAMENTO, CA	144 GRAND ISLAND, NE	1	1,029	12,348
177 SACRAMENTO, CA	162 PHOENIX, AZ	1	722	8,664
177 SACRAMENTO, CA	168 SPOKANE, WA	1	345	4,140
177 SACRAMENTO, CA	172 PORTLAND, OR	6	2,070	24,840
177 SACRAMENTO, CA	174 REDDING, CA	2	690	8,280
177 SACRAMENTO, CA	....	18	11,316	135,792
178 STOCKTON-MODESTO, CA	4 BOSTON, MA	1	641	7,692
178 STOCKTON-MODESTO, CA	6 HARTFORD-NEW HAVEN-SPRINGFLD,	1	641	7,692
178 STOCKTON-MODESTO, CA	15 ERIE, PA	1	614	7,368
178 STOCKTON-MODESTO, CA	18 PHILADELPHIA, PA	1	674	8,088
178 STOCKTON-MODESTO, CA	19 BALTIMORE, MD	1	722	8,664
178 STOCKTON-MODESTO, CA	83 CHICAGO, IL	1	1,029	12,348
178 STOCKTON-MODESTO, CA	98 DUBUQUE, IA	1	1,029	12,348
178 STOCKTON-MODESTO, CA	122 HOUSTON, TX	3	1,746	20,952
178 STOCKTON-MODESTO, CA	125 DALLAS-FORT WORTH, TX	5	3,340	40,080
178 STOCKTON-MODESTO, CA	139 WICHITA, KS	1	674	8,088
178 STOCKTON-MODESTO, CA	143 OMAHA, NE	1	674	8,088
178 STOCKTON-MODESTO, CA	168 SPOKANE, WA	1	345	4,140
178 STOCKTON-MODESTO, CA	170 YAKIMA, WA	1	397	4,764
178 STOCKTON-MODESTO, CA	171 SEATTLE, WA	10	3,606	43,272
178 STOCKTON-MODESTO, CA	172 PORTLAND, OR	6	2,278	27,336

Appendix Table 6

TRAM DATA PRESUMED TO FIT RAIL NETWORK
BY BEA ORIGIN AND DESTINATION

ORIGIN BEA	DESTINATION BEA	SITING COUNT	FACTORED MONTHLY COUNT	FACTORED ANNUAL COUNT
178 STOCKTON-MODESTO, CA	173 EUGENE, OR	1	345	4,140
178 STOCKTON-MODESTO, CA	....	36	18,755	225,060
179 FRESNO-BAKERSFIELD, CA	12 NEW YORK, NY	1	641	7,692
179 FRESNO-BAKERSFIELD, CA	19 BALTIMORE, MD	2	820	9,840
179 FRESNO-BAKERSFIELD, CA	20 WASHINGTON, DC	2	1,282	15,384
179 FRESNO-BAKERSFIELD, CA	71 DETROIT, MI	2	1,282	15,384
179 FRESNO-BAKERSFIELD, CA	83 CHICAGO, IL	1	674	8,088
179 FRESNO-BAKERSFIELD, CA	105 KANSAS CITY, MO	1	674	8,088
179 FRESNO-BAKERSFIELD, CA	111 LITTLE ROCK-N. LITTLE ROCK, AR	1	410	4,920
179 FRESNO-BAKERSFIELD, CA	125 DALLAS-FORT WORTH, TX	1	641	7,692
179 FRESNO-BAKERSFIELD, CA	135 AMARILLO, TX	1	641	7,692
179 FRESNO-BAKERSFIELD, CA	162 PHOENIX, AZ	1	410	4,920
179 FRESNO-BAKERSFIELD, CA	171 SEATTLE, WA	4	1,484	17,808
179 FRESNO-BAKERSFIELD, CA	172 PORTLAND, OR	1	397	4,764
179 FRESNO-BAKERSFIELD, CA	173 EUGENE, OR	1	345	4,140
179 FRESNO-BAKERSFIELD, CA	....	19	9,701	116,412
180 LOS ANGELES, CA	4 BOSTON, MA	5	3,373	40,476
180 LOS ANGELES, CA	7 ALBANY-SCHENECTADY-TROY, NY	1	614	7,368
180 LOS ANGELES, CA	10 BUFFALO, NY	1	410	4,920
180 LOS ANGELES, CA	12 NEW YORK, NY	12	8,016	96,192
180 LOS ANGELES, CA	16 PITTSBURGH, PA	2	1,024	12,288
180 LOS ANGELES, CA	17 HARRISBURG-YORK-LANCASTER, PA	1	614	7,368
180 LOS ANGELES, CA	18 PHILADELPHIA, PA	2	1,132	13,584
180 LOS ANGELES, CA	19 BALTIMORE, MD	1	722	8,664
180 LOS ANGELES, CA	20 WASHINGTON, DC	4	2,360	28,320
180 LOS ANGELES, CA	55 MEMPHIS, TN	4	2,156	25,872
180 LOS ANGELES, CA	65 CLEVELAND, OH	2	1,024	12,288
180 LOS ANGELES, CA	70 TOLEDO, OH	1	410	4,920
180 LOS ANGELES, CA	71 DETROIT, MI	4	2,564	30,768
180 LOS ANGELES, CA	74 LANSING-KALAMAZOO, MI	1	614	7,368
180 LOS ANGELES, CA	83 CHICAGO, IL	9	5,625	67,500
180 LOS ANGELES, CA	96 MINNEAPOLIS-ST. PAUL, MN	5	3,070	36,840
180 LOS ANGELES, CA	104 DES MOINES, IA	2	1,643	19,716

Appendix Table 6

TRAM DATA PRESUMED TO FIT RAIL NETWORK
BY BEA ORIGIN AND DESTINATION

ORIGIN BEA	DESTINATION BEA	SITING COUNT	FACTORED MONTHLY COUNT	FACTORED ANNUAL COUNT
180 LOS ANGELES, CA	105 KANSAS CITY, MO	1	614	7,368
180 LOS ANGELES, CA	111 LITTLE ROCK-N. LITTLE ROCK, AR	3	1,746	20,952
180 LOS ANGELES, CA	113 NEW ORLEANS, LA	3	1,542	18,504
180 LOS ANGELES, CA	122 HOUSTON, TX	8	5,668	68,016
180 LOS ANGELES, CA	123 AUSTIN, TX	2	1,444	17,328
180 LOS ANGELES, CA	125 DALLAS-FORT WORTH, TX	12	7,416	88,992
180 LOS ANGELES, CA	133 EL PASO, TX	1	410	4,920
180 LOS ANGELES, CA	135 AMARILLO, TX	1	614	7,368
180 LOS ANGELES, CA	139 WICHITA, KS	1	614	7,368
180 LOS ANGELES, CA	141 TOPEKA, KS	1	614	7,368
180 LOS ANGELES, CA	160 ALBUQUERQUE, NM	5	3,178	38,136
180 LOS ANGELES, CA	161 TUCSON, AZ	8	5,776	69,312
180 LOS ANGELES, CA	162 PHOENIX, AZ	7	3,182	38,184
180 LOS ANGELES, CA	168 SPOKANE, WA	3	1,139	13,668
180 LOS ANGELES, CA	170 YAKIMA, WA	1	397	4,764
180 LOS ANGELES, CA	171 SEATTLE, WA	26	9,334	112,008
180 LOS ANGELES, CA	172 PORTLAND, OR	19	6,867	82,404
180 LOS ANGELES, CA	174 REDDING, CA	2	690	8,280
180 LOS ANGELES, CA	176 SAN FRANCISCO-OAKLAND-SAN JOSE	1	345	4,140
180 LOS ANGELES, CA	177 SACRAMENTO, CA	1	397	4,764
180 LOS ANGELES, CA	179 FRESNO-BAKERSFIELD, CA	1	345	4,140
180 LOS ANGELES, CA	180 LOS ANGELES, CA	2	820	9,840
180 LOS ANGELES, CA	....	166	88,523	1,062,276
....		602	342,092	4,105,104

Appendix Table 7

INTERMODAL HUB VOLUMES FOR YEAR 1987
BASED ON COMBINED INTERMODAL, BOXABLE, AND TRAM DIVERSION FEUS
DATA SOURCES: 1987 ICC CARLOAD WAYBILL SAMPLE AND TRAM TRUCK DIVERSIONS

BEA NUMBER AND NAME	FEUS ORIGINATED	FEUS TERMINATED	TOTAL FEU VOLUME
1 BANGOR, ME	440	80	520
2 PORTLAND-LEWISTON, ME	80	400	480
3 BURLINGTON, VT	2,544	2,236	4,780
4 BOSTON, MA	81,891	143,950	225,841
6 HARTFORD-NEW HAVEN-SPRINGFLD, CT-MA	37,880	35,905	73,785
7 ALBANY-SCHENECTADY-TROY, NY	22,440	15,503	37,943
8 SYRACUSE-UTICA, NY	28,136	9,840	37,976
9 ROCHESTER, NY	44,789	8,525	53,314
10 BUFFALO, NY	34,171	29,020	63,191
11 BINGHAMTON-ELMIRA, NY	360	1,000	1,360
12 NEW YORK, NY	355,306	436,127	791,433
14 WILLIAMSPORT, PA	100	0	100
15 ERIE, PA	7,692	7,368	15,060
16 PITTSBURGH, PA	15,648	20,416	36,064
17 HARRISBURG-YORK-LANCASTER, PA	25,833	48,049	73,882
18 PHILADELPHIA, PA	140,837	202,708	343,545
19 BALTIMORE, MD	71,051	113,204	184,255
20 WASHINGTON, DC	55,568	117,176	172,744
21 ROANOKE-LYNCHBURG, VA	1,000	1,080	2,080
22 RICHMOND, VA	2,600	3,640	6,240
23 NORFOLK-VIRGINIA BCH-NEWPT NEWS, VA	55,580	55,564	111,144
24 ROCKY MNT-WILSON-GREENVILLE, NC	1,400	1,120	2,520
25 WILMINGTON, NC	5,840	4,920	10,760
26 FAYETTEVILLE, NC	320	0	320
28 GREENSBORO-WINSTON-SALEM-HIGHPNT, NC	14,160	13,760	27,920
29 CHARLOTTE, NC	21,980	23,000	44,980
30 ASHEVILLE, NC	2,940	2,160	5,100
31 GREENVILLE-SPARTANBURG, SC	6,840	5,520	12,360
34 CHARLESTON-NORTH CHARLESTON, SC	51,228	62,536	113,764
35 AUGUSTA, GA	2,640	520	3,160
36 ATLANTA, GA	141,684	122,072	263,756
37 COLUMBUS, GA	1,800	960	2,760
38 MACON, GA	20,120	4,960	25,080
39 SAVANNAH, GA	55,692	59,520	115,212
40 ALBANY, GA	2,280	680	2,960
41 JACKSONVILLE, FL	141,732	152,040	293,772
42 ORLANDO-MELBOURNE-DAYTONA BEACH, FL	20,920	34,200	55,120
43 MIAMI-FORT LAUDERDALE, FL	83,848	174,068	257,916
44 TAMPA-ST. PETERSBURG, FL	15,240	38,600	53,840
46 PENSACOLA-PANAMA CITY, FL	400	180	580
47 MOBILE, AL	26,420	14,652	41,072
48 MONTGOMERY, AL	6,760	2,720	9,480
49 BIRMINGHAM, AL	43,300	40,504	83,804
50 HUNTSVILLE-FLORENCE, AL	5,000	3,320	8,320
51 CHATTANOOGA, TN	21,760	11,880	33,640
52 JOHNSON CTY-KINGSPT-BRISTOL, TN-VA	14,880	9,560	24,440
53 KNOXVILLE, TN	3,400	3,960	7,360
54 NASHVILLE, TN	29,320	23,880	53,200
55 MEMPHIS, TN	191,356	152,441	343,797
56 PADUCAH, KY	1,100	1,380	2,480

Appendix Table 7

INTERMODAL HUB VOLUMES FOR YEAR 1987
BASED ON COMBINED INTERMODAL, BOXABLE, AND TRAM DIVERSION FEUS
DATA SOURCES: 1987 ICC CARLOAD WAYBILL SAMPLE AND TRAM TRUCK DIVERSIONS

BEA NUMBER AND NAME	FEUS ORIGINATED	FEUS TERMINATED	TOTAL FEU VOLUME
57 LOUISVILLE, KY	31,580	26,056	57,636
58 LEXINGTON, KY	960	1,160	2,120
65 CLEVELAND, OH	48,057	55,117	103,174
66 COLUMBUS, OH	42,775	33,204	75,979
67 CINCINNATI, OH	55,952	44,436	100,388
70 TOLEDO, OH	28,345	15,450	43,795
71 DETROIT, MI	117,439	129,367	246,806
72 SAGINAW-BAY CITY, MI	0	100	100
73 GRAND RAPIDS, MI	2,200	520	2,720
74 LANSING-KALAMAZOO, MI	0	7,368	7,368
75 SOUTH BEND, IN	120	100	220
76 FORT WAYNE, IN	8,968	1,040	10,008
78 ANDERSON-MUNCIE, IN	0	80	80
79 INDIANAPOLIS, IN	5,860	7,938	13,798
80 EVANSVILLE, IN	8,200	4,520	12,720
82 LAFAYETTE, IN	4,436	8,068	12,504
83 CHICAGO, IL	1,402,006	1,258,487	2,660,493
84 CHAMPAIGN-URBANA, IL	280	160	440
85 SPRINGFIELD-DECATUR, IL	8,782	0	8,782
86 QUINCY, IL	120	0	120
87 PEORIA, IL	17,780	11,132	28,912
88 ROCKFORD, IL	0	3,904	3,904
89 MILWAUKEE, WI	10,980	10,200	21,180
90 MADISON, WI	1,120	200	1,320
91 LA CROSSE, WI	80	0	80
92 EAU CLAIRE, WI	880	700	1,580
93 WAUSAU, WI	700	1,100	1,800
94 APLETON-GREEN BAY-OSHKOSH, WI	9,800	7,920	17,720
95 DULUTH, MN	0	80	80
96 MINNEAPOLIS-ST. PAUL, MN	98,695	126,853	225,548
99 DAVENPORT-ROCK ISLAND-MOLINE, IA-IL	17,468	1,164	18,632
100 CEDAR RAPIDS, IA	13,748	800	14,548
101 WATERLOO, IA	120	0	120
102 FORT DODGE, IA	480	0	480
103 SIOUX CITY, IA	960	100	1,060
104 DES MOINES, IA	47,036	24,316	71,352
105 KANSAS CITY, MO	213,494	187,277	400,771
107 ST. LOUIS, MO	203,948	158,250	362,198
108 SPRINGFIELD, MO	9,960	12,056	22,016
110 FORT SMITH, AR	6,960	1,200	8,160
111 LITTLE ROCK-N. LITTLE ROCK, AR	40,824	34,572	75,396
112 JACKSON, MS	6,780	10,600	17,380
113 NEW ORLEANS, LA	144,944	171,905	316,849
114 BATON ROUGE, LA	3,400	440	3,840
116 LAKE CHARLES, LA	2,348	2,280	4,628
117 SHREVEPORT, LA	3,380	3,132	6,512
118 MONROE, LA	0	40	40
119 TEXARKANA, TX	4,180	2,320	6,500
120 TYLER-LONGVIEW, TX	9,660	4,080	13,740
121 BEAUMONT-PORT ARTHUR, TX	20,210	400	20,610

Appendix Table 7

INTERMODAL HUB VOLUMES FOR YEAR 1987
BASED ON COMBINED INTERMODAL, BOXABLE, AND TRAM DIVERSION FEUS
DATA SOURCES: 1987 ICC CARLOAD WAYBILL SAMPLE AND TRAM TRUCK DIVERSIONS

BEA NUMBER AND NAME	FEUS ORIGINATED	FEUS TERMINATED	TOTAL FEU VOLUME
122 HOUSTON, TX	164,562	248,419	412,981
123 AUSTIN, TX	100	17,648	17,748
124 WACO-KILLEEN-TEMPLE, TX	780	600	1,380
125 DALLAS-FORT WORTH, TX	409,703	390,574	800,277
127 ABILENE, TX	40	0	40
129 SAN ANTONIO, TX	37,160	30,724	67,884
130 CORPUS CHRISTI, TX	180	920	1,100
131 BROWNSVILLE-MCALLEN-HARLINGEN, TX	3,640	1,744	5,384
132 ODESSA-MIDLAND, TX	8,932	40	8,972
133 ELPASO, TX	31,024	21,620	52,644
134 LUBBOCK, TX	2,388	3,192	5,580
135 AMARILLO, TX	29,845	21,394	51,239
137 OKLAHOMA CITY, OK	7,364	18,668	26,032
138 TULSA, OK	14,764	16,574	31,338
139 WICHITA, KS	26,846	16,476	43,322
141 TOPEKA, KS	5,575	8,688	14,263
142 LINCOLN, NE	10,820	5,308	16,128
143 OMAHA, NE	70,834	68,484	139,318
144 GRAND ISLAND, NE	120	12,348	12,468
145 SCOTTSBLUFF, NE	240	400	640
146 RAPID CITY, SD	800	0	800
147 SIOUX FALLS, SD	0	40	40
149 FARGO-MOORHEAD, ND-MN	4,360	3,640	8,000
150 GRAND FORKS, ND	2,560	200	2,760
153 GREAT FALLS, MT	520	760	1,280
154 MISSOULA, MT	8,304	400	8,704
155 BILLINGS, MT	4,960	4,240	9,200
156 CHEYENNE-CASPER, WY	14,628	2,000	16,628
157 DENVER, CO	55,381	85,864	141,245
158 COLORADO SPRINGS-PUEBLO, CO	80	700	780
159 GRAND JUNCTION, CO	180	1,300	1,480
160 ALBUQUERQUE, NM	10,776	55,716	66,492
161 TUCSON, AZ	1,220	12,889	14,109
162 PHOENIX AZ	90,687	247,510	338,197
163 LAS VEGAS, NV	1,120	2,520	3,640
164 RENO, NV	6,200	72,173	78,373
165 SALT LAKE CITY-OGDEN, UT	46,484	135,400	181,884
166 POCATELLO-IDAHO FALLS, ID	1,360	520	1,880
167 BOISE CITY, ID	2,320	1,052	3,372
168 SPOKANE, WA	33,696	48,502	82,198
169 RICHLAND, WA	44,403	19,788	64,191
170 YAKIMA, WA	52,993	12,928	65,921
171 SEATTLE, WA	395,743	449,164	844,907
172 PORTLAND, OR	273,380	321,483	594,863
173 EUGENE, OR	54,993	320	55,313
174 REDDING, CA	40	40	80
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	316,927	510,224	827,151
177 SACRAMENTO, CA	103,011	61,406	164,417
178 STOCKTON-MODESTO, CA	241,973	102,748	344,721
179 FRESNO-BAKERSFIELD, CA	165,137	47,964	213,101

Appendix Table 7

INTERMODAL HUB VOLUMES FOR YEAR 1987
BASED ON COMBINED INTERMODAL, BOXABLE, AND TRAM DIVERSION FEUS
DATA SOURCES: 1987 ICC CARLOAD WAYBILL SAMPLE AND TRAM TRUCK DIVERSIONS

BEA NUMBER AND NAME	FEUS ORIGINATED	FEUS TERMINATED	TOTAL FEU VOLUME
180 LOS ANGELES, CA	1,454,438	1,204,944	2,659,382
181 SAN DIEGO, CA	4,368	3,008	7,376
185 MARITIMES	2,280	0	2,280
186 QUEBEC	57,260	0	57,260
187 ONTARIO	24,960	11,000	35,960
188 MANITOBA	1,500	0	1,500
189 SASKATCHEWAN	200	0	200
190 ALBERTA	3,840	0	3,840
191 BRITISH COLUMBIA	11,920	3,320	15,240
192 PUERTO RICO	440	0	440

Appendix Table 8

INTERMODAL HUB VOLUMES FOR YEAR 2000
BASED ON COMBINED INTERMODAL, BOXABLE, AND TRAM DIVERSION FEUS
DATA SOURCES: 1987 ICC CARLOAD WAYBILL SAMPLE WITH ASSUMED 4 PERCENT
ANNUAL GROWTH AND TRAM TRUCK DIVERSIONS

BEA NUMBER AND NAME	FEUS ORIGINATED	FEUS TERMINATED	TOTAL FEU VOLUME
1 BANGOR, ME	733	133	866
2 PORTLAND-LEWISTON, ME	134	669	803
3 BURLINGTON, VT	4,236	3,723	7,959
4 BOSTON, MA	120,011	202,758	322,769
6 HARTFORD-NEW HAVEN-SPRINGFLD, CT-MA	49,485	54,672	104,157
7 ALBANY-SCHENECTADY-TROY, NY	24,037	20,915	44,952
8 SYRACUSE-UTICA, NY	33,259	16,388	49,647
9 ROCHESTER, NY	49,215	14,196	63,411
10 BUFFALO, NY	38,192	36,838	75,030
11 BINGHAMTON-ELMIRA, NY	601	1,666	2,267
12 NEW YORK, NY	507,453	623,809	1,131,262
14 WILLIAMSPORT, PA	167	0	167
15 ERIE, PA	7,692	7,368	15,060
16 PITTSBURGH, PA	20,678	25,824	46,502
17 HARRISBURG-YORK-LANCASTER, PA	37,637	75,109	112,746
18 PHILADELPHIA, PA	183,302	306,250	489,552
19 BALTIMORE, MD	108,076	170,425	278,501
20 WASHINGTON, DC	84,318	160,663	244,981
21 ROANOKE-LYNCHBURG, VA	1,667	1,800	3,467
22 RICHMOND, VA	4,330	6,061	10,391
23 NORFOLK-VIRGINIA BCH-NEWPT NEWS, VA	92,544	92,520	185,064
24 ROCKY MNT-WILSON-GREENVILLE, NC	2,331	1,865	4,196
25 WILMINGTON, NC	9,725	8,192	17,917
26 FAYETTEVILLE, NC	533	0	533
28 GREENSBORO-WINSTON-SALEM-HIGHPNT, NC	23,578	22,915	46,493
29 CHARLOTTE, NC	36,604	38,298	74,902
30 ASHEVILLE, NC	4,897	3,597	8,494
31 GREENVILLE-SPARTANBURG, SC	11,391	9,196	20,587
34 CHARLESTON-NORTH CHARLESTON, SC	85,303	104,129	189,432
35 AUGUSTA, GA	4,396	866	5,262
36 ATLANTA, GA	235,913	203,259	439,172
37 COLUMBUS, GA	2,999	1,598	4,597
38 MACON, GA	33,506	8,264	41,770
39 SAVANNAH, GA	92,731	99,108	191,839
40 ALBANY, GA	3,799	1,134	4,933
41 JACKSONVILLE, FL	235,996	253,162	489,158
42 ORLANDO-MELBOURNE-DAYTONA BEACH, FL	34,834	56,947	91,781
43 MIAMI-FORT LAUDERDALE, FL	139,615	289,837	429,452
44 TAMPA-ST. PETERSBURG, FL	25,378	64,272	89,650
46 PENSACOLA-PANAMA CITY, FL	666	301	967
47 MOBILE, AL	43,993	24,399	68,392
48 MONTGOMERY, AL	11,259	4,533	15,792
49 BIRMINGHAM, AL	72,096	67,442	139,538
50 HUNTSVILLE-FLORENCE, AL	8,327	5,529	13,856
51 CHATTANOOGA, TN	36,234	19,786	56,020
52 JOHNSON CTY-KINGSPT-BRISTOL, TN-VA	24,776	15,922	40,698
53 KNOXVILLE, TN	5,665	6,597	12,262
54 NASHVILLE, TN	48,819	39,764	88,583
55 MEMPHIS, TN	299,794	236,622	536,416

Appendix Table 8

INTERMODAL HUB VOLUMES FOR YEAR 2000
BASED ON COMBINED INTERMODAL, BOXABLE, AND TRAM DIVERSION FEUS
DATA SOURCES: 1987 ICC CARLOAD WAYBILL SAMPLE WITH ASSUMED 4 PERCENT
ANNUAL GROWTH AND TRAM TRUCK DIVERSIONS

BEA NUMBER AND NAME	FEUS ORIGINATED	FEUS TERMINATED	TOTAL FEU VOLUME
56 PADUCAH, KY	1,833	2,300	4,133
57 LOUISVILLE, KY	52,585	43,391	95,976
58 LEXINGTON, KY	1,603	1,934	3,537
65 CLEVELAND, OH	58,865	67,179	126,044
66 COLUMBUS, OH	71,226	55,289	126,515
67 CINCINNATI, OH	93,172	73,994	167,166
70 TOLEDO, OH	38,987	25,729	64,716
71 DETROIT, MI	171,940	163,002	334,942
72 SAGINAW-BAY CITY, MI	0	167	167
73 GRAND RAPIDS, MI	3,664	866	4,530
74 LANSING-KALAMAZOO, MI	0	7,368	7,368
75 SOUTH BEND, IN	200	167	367
76 FORT WAYNE, IN	9,553	1,731	11,284
78 ANDERSON-MUNCIE, IN	0	134	134
79 INDIANAPOLIS, IN	9,760	13,219	22,979
80 EVANSVILLE, IN	13,651	7,529	21,180
82 LAFAYETTE, IN	7,387	13,434	20,821
83 CHICAGO, IL	2,215,015	2,017,302	4,232,317
84 CHAMPAIGN-URBANA, IL	466	267	733
85 SPRINGFIELD-DECATUR, IL	8,860	0	8,860
86 QUINCY, IL	200	0	200
87 PEORIA, IL	29,610	18,537	48,147
88 ROCKFORD, IL	0	6,501	6,501
89 MILWAUKEE, WI	18,287	16,988	35,275
90 MADISON, WI	1,868	334	2,202
91 LA CROSSE, WI	133	0	133
92 EAU CLAIRE, WI	1,466	1,166	2,632
93 WAUSAU, WI	1,166	1,833	2,999
94 APLETON-GREEN BAY-OSHKOSH, WI	16,321	13,190	29,511
95 DULUTH, MN	0	134	134
96 MINNEAPOLIS-ST. PAUL, MN	146,326	181,346	327,672
99 DAVENPORT-ROCK ISLAND-MOLINE, IA-IL	20,875	1,940	22,815
100 CEDAR RAPIDS, IA	14,681	1,334	16,015
101 WATERLOO, IA	200	0	200
102 FORT DODGE, IA	799	0	799
103 SIOUX CITY, IA	1,599	167	1,766
104 DES MOINES, IA	55,194	27,378	82,572
105 KANSAS CITY, MO	328,572	285,131	613,703
107 ST. LOUIS, MO	333,829	263,508	597,337
108 SPRINGFIELD, MO	16,589	20,075	36,664
110 FORT SMITH, AR	11,590	1,998	13,588
111 LITTLE ROCK-N. LITTLE ROCK, AR	50,770	40,362	91,132
112 JACKSON, MS	11,291	17,654	28,945
113 NEW ORLEANS, LA	229,040	268,817	497,857
114 BATON ROUGE, LA	5,664	735	6,399
116 LAKE CHARLES, LA	3,910	3,798	7,708
117 SHREVEPORT, LA	5,631	5,216	10,847
118 MONROE, LA	0	67	67
119 TEXARKANA, TX	6,961	3,864	10,825

Appendix Table 8

INTERMODAL HUB VOLUMES FOR YEAR 2000
BASED ON COMBINED INTERMODAL, BOXABLE, AND TRAM DIVERSION FEUS
DATA SOURCES: 1987 ICC CARLOAD WAYBILL SAMPLE WITH ASSUMED 4 PERCENT
ANNUAL GROWTH AND TRAM TRUCK DIVERSIONS

BEA NUMBER AND NAME	FEUS ORIGINATED	FEUS TERMINATED	TOTAL FEU VOLUME
120 TYLER-LONGVIEW, TX	16,088	6,796	22,884
121 BEAUMONT-PORT ARTHUR, TX	23,838	667	24,505
122 HOUSTON, TX	268,254	351,195	619,449
123 AUSTIN, TX	167	17,861	18,028
124 WACO-KILLEEN-TEMPLE, TX	1,299	999	2,298
125 DALLAS-FORT WORTH, TX	488,595	524,888	1,013,483
127 ABILENE, TX	67	0	67
129 SAN ANTONIO, TX	61,877	51,160	113,037
130 CORPUS CHRISTI, TX	301	1,532	1,833
131 BROWNSVILLE-MCALLEN-HARLINGEN, TX	6,062	2,906	8,968
132 ODESSA-MIDLAND, TX	9,111	67	9,178
133 ELPASO, TX	38,158	29,559	67,717
134 LUBBOCK, TX	3,975	5,316	9,291
135 AMARILLO, TX	36,407	25,608	62,015
137 OKLAHOMA CITY, OK	12,263	31,085	43,348
138 TULSA, OK	24,587	27,597	52,184
139 WICHITA, KS	34,685	17,156	51,841
141 TOPEKA, KS	9,284	9,566	18,850
142 LINCOLN, NE	18,022	8,836	26,858
143 OMAHA, NE	101,688	108,657	210,345
144 GRAND ISLAND, NE	200	12,348	12,548
145 SCOTTSBLUFF, NE	400	666	1,066
146 RAPID CITY, SD	1,332	0	1,332
147 SIOUX FALLS, SD	0	67	67
149 FARGO-MOORHEAD, ND-MN	7,261	6,063	13,324
150 GRAND FORKS, ND	4,262	333	4,595
153 GREAT FALLS, MT	867	1,267	2,134
154 MISSOULA, MT	13,828	666	14,494
155 BILLINGS, MT	8,261	7,060	15,321
156 CHEYENNE-CASPER, WY	16,145	3,330	19,475
157 DENVER, CO	92,215	142,976	235,191
158 COLORADO SPRINGS-PUEBLO, CO	134	1,166	1,300
159 GRAND JUNCTION, CO	300	2,165	2,465
160 ALBUQUERQUE, NM	13,043	62,511	75,554
161 TUCSON, AZ	2,031	15,699	17,730
162 PHOENIX AZ	102,225	290,181	392,406
163 LAS VEGAS, NV	1,865	4,197	6,062
164 RENO, NV	10,329	79,402	89,731
165 SALT LAKE CITY-OGDEN, UT	69,189	162,876	232,065
166 POCATELLO-IDAHO FALLS, ID	2,266	866	3,132
167 BOISE CITY, ID	3,865	1,752	5,617
168 SPOKANE, WA	41,928	54,736	96,664
169 RICHLAND, WA	55,757	24,740	80,497
170 YAKIMA, WA	56,548	15,190	71,738
171 SEATTLE, WA	556,373	588,411	1,144,784
172 PORTLAND, OR	373,967	394,191	768,158
173 EUGENE, OR	88,817	535	89,352
174 REDDING, CA	67	67	134
176 SAN FRANCISCO-OAKLAND-SAN JOSE, CA	406,286	648,293	1,054,579

Appendix Table 8

INTERMODAL HUB VOLUMES FOR YEAR 2000
BASED ON COMBINED INTERMODAL, BOXABLE, AND TRAM DIVERSION FEUS
DATA SOURCES: 1987 ICC CARLOAD WAYBILL SAMPLE WITH ASSUMED 4 PERCENT
ANNUAL GROWTH AND TRAM TRUCK DIVERSIONS

BEA NUMBER AND NAME	FEUS ORIGINATED	FEUS TERMINATED	TOTAL FEU VOLUME
177 SACRAMENTO, CA	124,782	72,256	197,038
178 STOCKTON-MODESTO, CA	282,371	113,880	396,251
179 FRESNO-BAKERSFIELD, CA	203,575	59,974	263,549
180 LOS ANGELES, CA	1,810,753	1,553,448	3,364,201
181 SAN DIEGO, CA	7,273	5,011	12,284
185 MARITIMES	3,797	0	3,797
186 QUEBEC	95,344	0	95,344
187 ONTARIO	41,562	18,321	59,883
188 MANITOBA	2,499	0	2,499
189 SASKATCHEWAN	333	0	333
190 ALBERTA	6,394	0	6,394
191 BRITISH COLUMBIA	19,851	5,529	25,380
192 PUERTO RICO	733	0	733

Appendix Table 9
TERMINAL CAPACITY AT MAJOR HUBS

RR	Terminal	Acres	Track Feet	Car Capacity Flat Cars	Stack Cars	Estimated Daily Lift Capacity	Estimated Annual Lift Capacity	Lift Machines Side-loaders	Over-head	Total	Actual 1987 Lifts	Actual 1988 Lifts
UP	LA	120	21,390	230	70	1,870	673,258		6	6	220,000	255,000
ATSF	LA	110	34,503	371	113	3,017	1,085,995	9	0	9	395,280	434,778
SP	LA	76	17,670	190	58	1,545	556,170	4	0	4	142,240	155,769
SP	Long Beach/ICTF	258	22,599	243	74	1,976	711,312	8	1	9	370,000	395,943
Subtotal		564	96,162	1,034	315	8,408	3,026,735	21	7	28	1,127,520	1,241,490
UP	Seattle	20	11,904	128	39	1,041	374,683	3		3	112,852	118,388
BN	Seattle	29	11,718	126	38	1,025	368,828			10	195,115	186,187
BN	Seattle	48	10,695	115	35	935	336,629			3	107,296	99,939
Subtotal		97	34,317	369	113	3,000	1,080,141	3	0	16	415,263	404,514
UP	Portland	50	6,300	68	21	551	198,295	2		2	91,236	88,422
BN	Portland	18	9,951	107	33	870	313,211			4	94,938	99,033
SP	Portland	22	2,325	25	8	203	73,180	4	0	4	51,280	53,717
Subtotal		90	18,576	200	61	1,624	584,687	6	0	10	237,454	241,172
10 CNW	Global One	110	15,624	168	51	1,366	491,771	2	4	6	256,000	330,300
UP	Chicago	32	10,416	112	34	911	327,848		2	2	83,791	77,443
GT	Chicago	33	7,161	77	23	626	225,395	3	2	5	59,084	60,247
CR	Chicago/S Layf	N/A	17,577	189	58	1,537	553,243	5		5	298,273	298,007
CR	Chicago/51st	30	6,696	72	22	585	210,759	3		3	89,846	101,884
CR	Chicago/47th	102	11,160	120	37	976	351,265	2	1	3	165,059	166,914
CSX	Ch/Forest Hill	22	18,414	198	60	1,610	579,588		2	2	151,380	120,460
CSX	Ch/Bedford Pk	280	42,700	459	140	3,733	1,343,999	4	3	7	144,000	235,921
NS	Chicago	11	11,160	120	37	976	351,265	4	2	6	125,377	135,673
SOO	Bensenville	47	24,180	260	79	2,114	761,075	3	1	4	104,524	80,737
SOO	Schiller Pk	45	7,905	85	26	691	248,813	4		4	84,078	78,111
ATSF	Chicago	128	27,621	297	91	2,415	869,381	2	6	8	498,098	532,673
ATSF	Galesburg	12	93	1	0	8	2,927	1	1	2	8,566	7,692
BN	Chicago/Cicero	11	29,016	312	95	2,537	913,290			10	389,602	355,935
BN	Chicago/W.Ave	9	6,138	66	20	537	193,196			2	48,334	41,359
Subtotal		872	235,861	2,536	773	20,622	7,423,814	33	24	69	2,506,012	2,623,356
SOO	St Paul	56	3,813	41	13	333	120,016	3		3	66,747	58,118
GT	Detroit	7	4,800	52	16	420	151,082	3	2	5	24,704	49,032
CR	Detroit	10	7,347	79	24	642	231,250	3		3	33,407	31,166
NS	Detroit	N/A	5,952	64	20	520	187,341	1	1	2	38,904	32,320
Subtotal		17	18,099	195	59	1,582	569,673	7	3	10	97,015	112,518

Appendix Table 9
TERMINAL CAPACITY AT MAJOR HUBS

RR	Terminal	Acres	Track Feet	Car Capacity Flat Cars	Car Capacity Stack Cars	Estimated Daily Lift Capacity	Estimated Annual Lift Capacity	Lift Machines Side-loaders	Lift Machines Over-head	Lift Machines Total	Actual 1987 Lifts	Actual 1988 Lifts
NS	Kansas City	3	2,700	29	9	236	84,984	0	0	0	16,125	14,904
UP	Kansas City	6	8,370	90	27	732	263,449	1		1	38,408	45,656
ATSF	Kansas City	40	5,952	64	20	520	187,341	0	3	3	113,399	151,741
BN	Kansas City	20	7,440	80	24	650	234,177			3	63,464	86,467
Subtotal		84	27,717	298	91	2,423	872,403	3	3	9	282,301	352,381
UP	Denver	45	7,750	83	25	678	243,934	1		1	30,270	24,580
ATSF	Denver	60	4,650	50	15	407	146,361	0	2	2	39,918	53,078
BN	Denver	26	8,091	87	27	707	254,667			3	95,180	106,000
Subtotal		131	20,491	220	67	1,792	644,962	1	2	6	165,368	183,658
UP	Houston		5,952	64	20	520	187,341					
ATSF	Houston	94	7,440	80	24	650	234,177	2	2	4	96,055	128,738
SP	Houston	91	11,253	121	37	984	354,192	3	1	4	132,681	146,600
SP	Houston/Barb Cut	5	5,487	59	18	480	172,705		2	2	34,450	35,512
Subtotal		190	30,132	324	99	2,634	948,416	5	5	10	263,186	310,850
UP	St Louis	30	5,859	63	19	512	184,414	2		2	46,920	57,485
CR	East St Louis	45	9,951	107	33	870	313,211	4		4	134,000	141,000
NS	St Louis	20	7,626	82	25	667	240,031	2		2	40,104	29,627
BN	St Louis	14	4,464	48	15	390	140,506			2	75,819	89,424
Subtotal		109	27,900	300	91	2,439	878,163	8	0	10	296,843	317,536
NS	Columbus	N/A	2,697	29	9	236	84,889	1		1	N/A	
CR	Columbus	40	4,929	53	16	431	155,142	3		3	82,888	91,422
Subtotal		40	7,626	82	25	667	240,031	4	0	4	82,888	91,422
CR	Kearney, NJ	80	16,833	181	55	1,472	529,825	8		8	343,319	341,660
CR	North Bergen	38	15,159	163	50	1,325	477,135	4		4	98,000	100,000
CSL	Little Ferry	18	6,625	71	22	579	208,524	2		2	na	43,788
Subtotal		136	38,617	415	127	3,376	1,215,485	14	0	14	441,319	485,448

Appendix Table 9
TERMINAL CAPACITY AT MAJOR HUBS

				Car Capacity		Estimated	Estimated	Lift Machines			Actual	Actual
RR	Terminal	Acres	Track Feet	Flat Cars	Stack Cars	Daily Lift Capacity	Annual Lift Capacity	Side-loaders	Over-head	Total	1987 Lifts	1988 Lifts
CSX	Baltimore	59	7,998	86	26	699	251,740	3		3	69,058	102,469
CR	Baltimore	32	5,301	57	17	463	166,851	2		2	59,000	71,000
Subtotal		91	13,299	143	44	1,163	418,591	5	0	5	128,058	173,469
CSX	New Orleans	6	5,580	60	18	488	175,633		2	2	54,541	79,827
NS	New Orleans	10	1,488	16	5	130	46,835		2	2	25,500	22,000
UP	New Orleans	2	2,325	25	8	203	73,180	1		1	26,203	11,367
SP	New Orleans	34	3,162	34	10	276	99,525	2	0	2	63,356	65,484
Subtotal		52	12,555	135	41	1,098	395,173	3	4	7	169,600	178,678
CSX	Atlanta	79	15,810	170	52	1,382	497,626	3	1	4	194,542	202,789
NS	Atlanta	N/A	9,304	100	31	813	292,847	2	6	8	146,588	169,727
Subtotal		79	25,114	270	82	2,196	790,473	5	7	12	341,130	372,516
NS	Memphis	9	1,953	21	6	171	61,471		2	2	35,000	35,000
CSL	Memphis	N/A	1,395	15	5	122	43,908	2		2	42,883	56,333
BN	Memphis	25	5,580	60	18	488	175,633			3	91,860	102,967
SP	Memphis	55	5,487	59	18	480	172,705	2	0	2	80,850	82,755
Subtotal		89	14,415	155	47	1,260	453,718	4	2	9	250,593	277,055

Source: Railroad contacts and published descriptions.